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Essays in Open Economy Macroeconomics with Borrowing Frictions

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RÉSUMÉ

Cette thèse comporte trois essais en macroéconomie en économie ouverte et commerce international. Je considère tour à tour les questions suivantes : sous quelles conditions est-il optimal pour un pays de former une union économique ? (essai 1) ; l'augmentation de la dispersion transversale des avoirs extérieurs nets des pays est-elle compatible avec une dispersion relativement stable des taux d'investissement ? (essai 2) ; le risque de perte de marché à l'exportation du fait de l'existence des zones de commerce préférentiel joue t-il un rôle dans la décision des pays exclus de négocier des accords commerciaux à leur tour ? (essai 3).

Le premier essai examine les conditions d'optimalité d'une union économique. Il s'intéresse à une motivation particulière : le partage du risque lié aux fluctuations du revenu. Dans la situation initiale, les pays ont très peu d'opportunités pour partager le risque à cause des frictions : les marchés financiers internationaux sont incomplets et il n'y pas de mécanisme pour faire respecter les contrats de crédit entre pays. Dans ce contexte, une union économique apparait comme un arrangement qui pallie à ces frictions entre les pays membres seulement. Cependant, l'union dans son ensemble continue de faire face à ces frictions lorsqu'elle échange avec le reste du monde. L'arbitrage clé dans le modèle est le suivant. D'un coté, l'intégration économique permet un meilleur partage du risque entre pays membres et la possibilité pour le partenaire pauvre d'utiliser la ligne de crédit du partenaire riche en cas de besoin. De l'autre coté, l'union peut faire face à une limite de crédit plus restrictive parce que résilier la dette extérieure est moins coûteux pour les membres l'union. De plus, le fait que le partenaire pauvre peut utiliser la limite de crédit du partenaire riche génère une externalité négative pour ce dernier qui se retrouve plus fréquemment contraint au niveau des marchés internationaux des capitaux. En conformité avec les faits observés sur l'intégration économique, le modèle prédit que les unions économiques sont relativement peu fréquentes, sont plus susceptibles d'être créées parmi des pays homogènes, et généralement riches.

Le deuxième essai porte sur la dispersion des avoirs extérieurs nets et la relation avec la dispersion des taux d'investissement. Au cours des récentes décennies, la dispersion croissante des déséquilibres extérieurs et les niveaux record atteints par certaines grandes économies ont reçu une attention considérable. On pourrait attribuer ce phénomène à une réduction des barrières aux mouvements internationaux des capitaux. Mais dans ce cas, il est légitime de s'attendre à une aug-

mentation de la dispersion au niveau des taux d'investissement ; ceci, parce que le financement des besoins en investissements constitue une raison fondamentale pour laquelle les pays échangent les capitaux. Les données indiquent cependant que la dispersion des taux d'investissement est restée relativement stable au cours des récentes décennies. Pour réconcilier ces faits, je construis un modèle d'équilibre général dynamique et stochastique où les pays sont hétérogènes en raison des chocs idiosyncratiques à leurs niveaux de productivité totale des facteurs. Au niveau des marchés internationaux des capitaux, le menu des actifs disponibles est restreint à une obligation sans risque et il n'y a pas de mécanisme pour faire respecter les contrats de crédit entre pays. A tout moment, un pays peut choisir de résilier sa dette extérieure sous peine d'exclusion financière et d'un coût direct. Ce coût direct reflète les canaux autres que l'exclusion financière à travers lesquels les pays en défaut sont pénalisés. Lorsque le modèle est calibré pour reproduire l'évolution de la dispersion transversale des avoirs extérieurs nets, il produit une dispersion relativement stable des taux d'investissement. La raison principale est que les incitations que les pays ont à investir sont liées à la productivité. Avec l'intégration financière, même si les opportunités d'emprunt se sont multipliées, les incitations à investir n'ont pas beaucoup changé. Ce qui permet de générer une dispersion accrue de la position des avoirs extérieurs nets des pays avec une dispersion relativement stable des taux d'investissement.

Le troisième essai analyse un aspect de l'interdépendance dans la formation des accords commerciaux préférentiels : j'examine empiriquement si le risque de diversion des exportations en faveur des pays membres des zones de commerce préférentiel est un facteur déterminant dans la décision des pays exclus de ces accords de négocier un accord à leur tour. Je construis un indicateur qui mesure le potentiel de diversion des exportations auquel font face les pays et estime un modèle probit de formation des zones de commerce préférentiel créées entre 1961 et 2005. Les résultats confirment que les pays confrontés à un plus grand potentiel de détournement des échanges sont plus susceptibles de former une zone de commerce préférentiel à leur tour.

Mots-clés : Marchés incomplets, Contraintes de crédit endogènes, Partage du risque, Intégration économique, Avoirs extérieurs nets, Investissement, Accords commerciaux préférentiels, Diversion commerciale, Modèle probit.

ABSTRACT

This thesis consists of three essays in open economic macroeconomics and international trade. I consider the following questions: Which countries find it individually optimal to form an economic union? (essay 1); is the rising cross-sectional dispersion in net foreign asset positions consistent with a relatively stable dispersion in investment rates? (essay 2); is the risk of trade diversion due to existing preferential trade areas an important factor in excluded countries decision to seek one? (essay 3).

The first essay studies the individual optimality of economic integration. It emphasizes the risk-sharing benefits of economic integration. In an initial situation, countries have very limited possibilities to share idiosyncratic endowment risk because of financial frictions: international financial markets are incomplete and contracts not enforceable. A union is an arrangement that solves both the market incompleteness and the lack of enforcement problems among member countries. The union as a whole still faces these frictions when trading in the world economy. The model emphasizes the following key trade-off. There are two benefits from economic integration: better risk-sharing among member countries and the possibility for poor partners to use the rich partners' credit lines. The cost are the following: borrowing limits become tighter because defaulting on international debt becomes less costly for union partners. Since poor partners may benefit from the rich partner's credit limit, this generates a negative externality: rich partners will find themselves more often borrowing-constrained in a union compared to standing alone in the world economy. Consistently with evidence on economic integration, the model predicts that economic unions occur relatively infrequently and are more likely to emerge among homogeneous and rich countries.

The rising dispersion of external imbalances over the recent decades and the record-high levels reached by some major economies has received considerable attention during the recent years. The second essay focuses on one of such imbalances: the net foreign asset positions (NFA). One can view this rising dispersion as a consequence of the reduction in barriers to capital flows. But in such case, one would expect the dispersion in investment rates to go up as well because one fundamental reason countries borrow and lend internationally is to finance their investments needs. Instead, the dispersion in investment rates was relatively stable. To explain this puzzling fact, I undertake a

quantitative analysis of the global dispersion of net foreign asset positions and investment rates. The framework is an integrated model of world economy where countries differences arise from idiosyncratic shocks to their total factor productivity levels. International capital flows is restricted: the menu of assets traded is exogenously restricted to a risk-free bond, and international lending contracts are not legally enforceable. At any time, a country may choose to repudiate its foreign debt subject to financial exclusion and an output cost. The output cost captures margins other than financial exclusion through which defaulting countries can be punished. When calibrated to match the evolution of the cross-sectional dispersion in net foreign asset positions, the model produces a relatively stable dispersion in investment rates. The reason is because the incentives to invest are related to the productivity, not to the borrowing and lending opportunities. Although the opportunities to borrow and lend internationally have increased, the incentives to invest have not changed much, thereby generating a large cross-sectional dispersion in NFA positions with a relatively stable dispersion in investment rates.

The third essay investigates empirically whether the risk of trade diversion faced by countries excluded from preferential trade areas (PTA) is determinant in their decision to seek a preferential trade agreement. Using the trade complementarity index, I derive a measure of the potential of trade diversion and estimate a probit model of the formation of PTAs between 1961 and 2005. The results show that country-pairs facing a larger potential of trade diversion are more likely to form a PTA in the future.

Keywords : Incomplete markets, Endogenous borrowing constraints, Risk sharing, Economic integration, Net foreign asset position, Investment rates, preferential trade agreements, Trade diversion, Probit model.

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CKL	Chang, Kim, and Lee [2009]
EC	European Community
EEC	European Economic Community
EFTA	European Free Trade Association
EL	Egger and Larch [2008]
EU	European Union
EWN II	External Wealth of Nations mark II
FDI	Foreign Direct Investment
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
NAFTA	North American Free Trade Area
NFA	Net Foreign Assets
PTA	Preferential Trade Agreement
PWT	Penn World Tables
SITC	Standard International Trade Classification
TFP	Total Factor Productivity
WTO	World Trade Organization

à la mémoire de mon père, Morbanh K.

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INTRODUCTION GÉNÉRALE

Cette thèse traite de trois sujets en macroéconomie en économie ouverte et commerce international. J'examine tour à tour (i) les conditions d'optimalité d'une union économique, (ii) l'accumulation des déséquilibres extérieurs et la relation avec l'investissement, et (iii) le rôle de l'interdépendence dans la prolifération des accords commerciaux préférentiels.

Le premier chapitre part d'un certain nombre de faits qui caractérisent l'intégration économique tel qu'observée actuellement : malgré une croissance accrue des initiatives, les zones de profonde intégration économique caractérisées par une libre circulation des facteurs de production et une harmonisation des politiques économiques et fiscales sont rares. Les zones existantes tendent à regrouper des pays qui ont des niveaux de revenu similaires, et dans la plupart des cas, des pays riches. Dans le cas de l'Union Européenne qui constitue aujourd'hui l'un des modèles avancés d'intégration, l'accession de la Grèce, du Portugal et l'Espagne, et récemment des pays de l'Europe de l'Est, n'a eu lieu qu'après une période de convergence des niveaux de revenu avec les pays membres. Ces faits sont intrigants parce que selon la théorie économique, on devrait observer plus souvent les unions économiques entre des pays qui sont plutôt hétérogènes. C'est le cas par exemple dans le modèle néoclassique de croissance : du fait des rendements d'échelle décroissants, l'intégration des marchés des capitaux permet aux pays pauvres de financer leur investissements sans avoir à sacrifier la consommation, et aux pays riches d'obtenir une meilleure rémunération pour leur épargne.

Le premier chapitre réconcilie ces faits avec la théorie en considérant un modèle d'équilibre général dynamique et stochastique de l'économie mondiale où les échanges sur les marchés internationaux des capitaux sont affectés par des frictions : les marchés financiers sont incomplets et il n'y pas de mécanisme pour faire respecter les contrats de crédit entre pays souverains. Une union économique émerge comme un arrangement qui pallie à ces frictions entre les pays membres. Cependant, l'union continue de faire face à ces frictions lorsqu'elle échange avec le reste du monde. L'arbitrage clé dans le modèle est le suivant. L'intégration économique permet un meilleur partage du risque entre pays membres et fournit au partenaire pauvre la possibilité d'utiliser la ligne de crédit du partenaire riche en cas de besoin. Il y'a cependant des coûts. Tout d'abord, la limite de crédit à laquelle les pays membres font face sur les marchés internationaux devient plus contraignante

parce que résilier la dette extérieure est moins coûteux pour les membres l'union : ils peuvent continuer à échanger entre eux en cas de défaut. Ensuite, le fait que le partenaire pauvre peut utiliser la limite de crédit du partenaire riche génère une externalité négative pour ce dernier qui se retrouve plus fréquemment contraint au niveau des marchés internationaux des capitaux. Ces ingrédients permettent au modèle de générer des résultats conformes avec les faits observés sur l'intégration économique.

Le deuxième essai s'intéresse à l'augmentation de la dispersion transversale des avoirs extérieurs nets et la relation avec la dispersion des taux d'investissement. Cette augmentation au cours des récentes décennies et les niveaux record atteints par certaines grandes économies comme les Etats-Unis et la Chine ont reçu une attention considérable. On pourrait attribuer ces déséquilibres à une réduction des barrières aux mouvements internationaux des capitaux. Mais dans ce cas, il est légitime de s'attendre à ce qu'ils s'accompagnent d'une augmentation dans la dispersion des taux d'investissement car le financement des investissements constitue une raison fondamentale pour laquelle les pays échangent les capitaux. Les données indiquent cependant que la dispersion des taux d'investissement est restée relativement stable au cours des dernières décennies.

Pour réconcilier ces faits, je construis un modèle dynamique d'équilibre général stochastique où les pays diffèrent en raison des chocs idiosyncratiques à leurs niveaux de productivité totale des facteurs. An niveau des marchés internationaux, il n'y a pas de mécanisme pour faire respecter les contrats de crédit entre pays. Les pays qui font défaut sur leur dette extérieure sont exclus des marchés futurs et subissent un coût direct : ce coût reflète les canaux autres que l'exclusion financière à travers lesquels les pays en défaut peuvent être pénalisés. Lorsque le modèle est calibré pour reproduire l'évolution de la dispersion transversale des avoirs extérieurs nets, il génère une dispersion relativement stable des taux d'investissement. La raison principale est que les incitations que les pays ont à investir sont liées à la productivité. Avec l'intégration financière, même si les opportunités d'emprunt ont augmentées, les incitations à investir n'ont pas beaucoup changé, ce qui permet de réconcilier une dispersion accrue des avoirs extérieurs nets avec une dispersion relativement stable des taux d'investissement.

La prolifération des accords commerciaux préférentiels est un élément dominant du système commercial multilatéral actuel. Dans le troisième essai, j'examine empiriquement un canal par lequel ces accords peuvent inciter les pays exclus à les joindre ou à en créer de nouveaux. Par

définition, les accords commerciaux sont discriminatoires : les importations en provenance des pays membres bénéficient d'un taux préférentiel par rapport aux pays exclus. Du coup, un pays peut perdre une partie importante de son marché d'exportation du fait de la création d'une zone de commerce préférentiel entre un pays partenaire et un pays compétiteur. Pour établir l'importance de ce canal, je construis une variable qui capture dans quelle mesure les exportations d'un pays sont exposées à cette diversion et estime un modèle Probit de formation des accords préférentiels. Les résultats montrent que le risque de diversion est déterminant dans la décision des pays de former des zones de commerce préférentiel.

CHAPITRE 1

ON THE INDIVIDUAL OPTIMALITY OF ECONOMIC INTEGRATION

1.1 Introduction

Which countries find it individually optimal to form an economic union? We emphasize a particular motivation for economic integration: improving risk sharing. An economic union is a small-scale arrangement where partners are better able to cope with the frictions that limit risk-sharing in the world economy.

We consider an initial situation in which countries are sitting in the world economy with very limited possibilities to sharing idiosyncratic endowment risk. Risk sharing is limited by two frictions. First, markets are incomplete since countries may only trade a non-contingent bond. Second, international lending contracts are not legally enforceable. At any time, a country may choose to repudiate its foreign debt. The sanction for doing so is the permanent exclusion from future trade in world markets. Our world economy model is a variant of Clarida [1990] and Huggett [1993], featuring self-enforcing borrowing limits along the lines of Kehoe and Levine [1993], Kocherlakota [1996], and Alvarez and Jermann [2001]. Versions of this setup have been studied previously in different contexts by Zhang [1997] and Krueger and Perri [2006]. [1]

We then consider the possibility that a pair of countries selected at random from the world economy is suddenly offered the possibility of forming an economic union. A union, by assumption, is an arrangement which solves both the market incompleteness and the lack of enforcement problems among member countries. The union as a whole, however, still faces these frictions when trading in world markets. Since the endowment risk facing union members cannot be fully diver-

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1. See Ábrahám and Cárceles-Poveda [2010] and Bai and Zhang [2010] for variants with capital accumulation. See also Castro [2005] for a variant with capital accumulation and endogenous but ad-hoc borrowing constraints.

sified away, they still have an interest in trading with the rest of the world. We focus on setting where union members coordinate their international borrowing and lending and default decisions, as if these decisions were taken by a central union authority.

The key trade-off our model emphasizes about union formation, from the perspective of each individual country, is the following. There are two benefits from economic integration. First, forming a union improves risk-sharing opportunities among member countries. Second, a union allows for poor partners to use the rich partners' credit lines. The latter is a benefit for poor partners only. There are also two costs of economic integration. First, borrowing limits become tighter, since defaulting on international debt becomes less costly for union partners. This happens because union partners may still share risk upon default. Second, since poor partners may benefit from the rich partner's credit limit, this generates a negative externality: rich partners will find themselves more often borrowing-constrained in a union compared to standing alone in the world economy.

Our model generates not only aggregate benefits, but also aggregate costs of economic integration. In addition, our model also generates disagreement about union formation, and the disagreement is the largest when the partners are more heterogeneous. These two ingredients provide a potential explanation for three seemingly puzzling empirical observations on economic integration: (i) deep economic integration is relatively rare, and when it does take place it tends to feature (ii) relatively homogeneous partners, and (iii) relatively richer partners. Our paper provides some empirical evidence documenting these regularities.

These observations are puzzling because, under a very broad set of circumstances, economic theory would imply that economic integration should happen often, particularly among heterogenous partners. For example, this would be the case for capital market integration in the neoclassical growth model, or goods market integration in either the Heckscher-Ohlin or the Ricardian models of trade. [2]

2. Union formation in intra-industry trade models, emphasizing scale economies and a taste for variety, have been analyzed in a static setting by Krugman [1991], Frankel, Stein, and Wei [1995], Frankel [1997] and Baier and Bergstrand [2004]. This type of model emphasizes size as a determinant of union formation: the larger and the more similar the partners' market sizes, the larger the gains from goods market integration. Larger unions profit more from scale economies, and size homogeneity lowers the losses from trade diversion. While Baier and Bergstrand [2004] find empirical support for these implications, our data also suggests that, *beyond market size*, the level and the dispersion in partner wealth matters for economic integration. Differently from this literature, our paper focuses on heterogeneity in per capita incomes and net foreign assets over GDP.

Our framework provides a very parsimonious explanation for these puzzling observations. Economic unions may not be formed if either the aggregate costs of economic integration are too large, or if there is disagreement among partners. Unions are unlikely to be formed among heterogeneous partners, since rich partners suffer from a negative externality imposed by poor partners. Finally, unions are also more likely to be formed among relatively rich partners because this lowers the likelihood of either country being borrowing-constrained in the future, and thus the effect of the negative externality.

This paper is related to a vast literature that has attempted to estimate the welfare gains from full international risk-sharing. This literature includes papers such as Cole and Obstfeld [1991], Backus, Kehoe, and Kydland [1992], Obstfeld [1994a, b], van Wincoop [1999], Wincoop [1994], Mendoza [1995], Tesar [1995], Lewis [2000], and Athanasoulis and van Wincoop [2000]. The typical exercise computes the average gain across countries of going from financial market autarky to complete markets, and entirely eliminating idiosyncratic country risk. Although the range of estimated welfare gains is large, the gains are still positive in nearly all the papers. The sole exception is Devereux and Smith [1994], who like this paper also model costs of sharing risk. In their case, sharing risk lowers precautionary saving, which lowers output growth and might lower welfare. We emphasize instead the tightening of credit constraints, and the negative externalities generated by poor union partners.

The present paper differs from this literature in several dimensions. First, beyond the magnitude of the welfare gains, this paper is mostly interested on their distribution across countries. Even if the average gains might be high, they can be very oddly distributed. If some countries actually experience a loss, as it is often the case in our model, risk sharing arrangements may not take place at all. This may explain the observed lack of international risk diversification, even in the presence of possibly large average welfare gains. Moreover, the main prediction of our model can be tested against the evidence, namely that feasible risk-sharing arrangements should occur among homogeneous and rich countries.

Second, this paper considers financial market integration as it typically takes place in the real world. That is, as voluntary arrangements among small sets of countries. Financially integrated countries are still unable to share risk with the rest of the world. Further, in our paper countries may save and self-insure in the absence of complete markets, whereas most of the literature abstracts

from this feature. Our paper computes welfare gains from international risk-sharing that take these important features into account.

A recent paper that has also looked at potential risk sharing arrangements within small sets of countries is Imbs and Mauro [2007]. Using actual data on the variance-covariance matrix of cross-country output growth, they uncover the number and configuration of countries that offer the best risk-sharing potential. Like in the rest of the international risk-sharing literature, they focus on going from autarky to complete markets, and do not feature neither costs of economic integration, nor a role for disagreement among partners. Their main finding is that most diversification gains are achieved in arrangements featuring a small (up to seven) number of countries, and in arrangements between highly volatile countries. As Imbs and Mauro [2007] recognize, a natural question is why we do not observe more arrangements of this type. They argue that this could be because unions might be particularly costly to sustain among volatile countries, since these also tend to have poor contract enforcement institutions. While our framework abstracts from cross-country differences in output volatility, it does provide an explicit, alternative reason for why small-size arrangements may not be feasible, even in the face of large aggregate gains.

The paper is organized as follows. Section 1.2 presents some evidence about union formation. Section 1.3 presents the model of the world economy. Section 1.4 characterizes the union. Section 1.5 presents the results. Section 1.7 concludes. Appendix I.1 provides some details about the data. Appendices I.2 and I.3 describe the decentralization of the union's allocation and the numerical algorithm, respectively.

1.2 Empirical Evidence

We start by providing some empirical evidence on the role of wealth levels and wealth inequality for union formation. By wealth we mean both income (y) and net foreign assets (b), both variables being potentially relevant according to our formal model. Our approach is to run a probit-gravity regression to test whether wealth levels contribute positively, and wealth inequality negatively, for the probability of union formation. Our regression specification is a straightforward adaptation of those commonly used in the empirical trade literature to test predictions over bilateral trade flows (see Frankel and Romer [1999], Frankel and Rose [2002]), similar to Baier and

Bergstrand [2004]. We consider:

$$\text{Prob}\left\{\text{Union}_{ij}=1|X_{ij}\right\}=\Phi(X'_{ij}\beta)$$

with

$$\begin{aligned}
X'_{ij}\beta &= \alpha_1+\alpha_2\ln(\text{dist})_{ij}+\alpha_3\text{adj}_{ij} \\
&+ \left(\alpha_4+\alpha_4^a\text{adj}_{ij}\right)\ln(\text{pop}_i\times\text{pop}_j)+\left(\alpha_5+\alpha_5^a\text{adj}_{ij}\right)\left|\ln\frac{\text{pop}_i}{\text{pop}_j}\right| \\
&+ \left(\theta_1+\theta_1^a\text{adj}_{ij}\right)\ln(y_i+y_j)+\left(\theta_2+\theta_2^a\text{adj}_{ij}\right)\left|\ln\frac{y_i}{y_j}\right| \\
&+ \left(\gamma_1+\gamma_1^a\text{adj}_{ij}\right)\left(\frac{b_i}{y_i}+\frac{b_j}{y_j}\right)+\left(\gamma_2+\gamma_2^a\text{adj}_{ij}\right)\left|\frac{b_i}{y_i}-\frac{b_j}{y_j}\right|.
\end{aligned}$$

The dependent variable is a dummy which gets the value of 1 if a union is formed between countries i and j, and 0 otherwise. The regressors in the first two lines of the regression equation concern factors deemed to be important for union formation but absent from our theoretical framework. The last two lines concern wealth levels and wealth heterogeneity, the key determinants in our theory.

We begin with the former set of regressors. We include two geographical factors commonly used in the gravity regression literature, the distance between the main economic centers of countries i and j (dist_{ij}), and a dummy variable capturing whether countries i and j share a common border (adj_{ij}). We also include overall size and a measure of heterogeneity in size, as potential determinants of union formation, where size is measured by population (pop_i). In particular, Baier and Bergstrand [2004] have found scale effects to be important for union formation, consistent with the predictions of a class of intra-industry trade models. In the last two lines, we include the overall income level of the country pair (i,j), a measure of the inequality in incomes between the two countries, and similarly for net foreign assets over income. We make the contribution of wealth levels and wealth inequality for union formation contingent upon whether countries share a border, and similarly for size. This specification finds a parallel in Frankel and Romer [1999].

To implement our regression analysis, we combine a variety of data sets. From version 6.3 of the Penn World Tables [Heston, Summers, and Aten, 2009] we obtain our measure of income

(real GDP per capita) and population. We obtain net foreign asset positions from Lane and Milesi-Ferretti [2007a]. We consider real GDP and nominal net foreign assets over nominal GDP averaged over five years (2000-2004) as our regressors, to prevent high frequency variation in these variables from affecting our results.

Our geographical data comes from Frankel and Rose [2002], and our union dummy is obtained from a comprehensive data set assembled by Baier and Bergstrand [2009]. Based on information from the World Trade Organization, among other sources, this data set provides information on which countries are engaged in any kind of regional trade arrangement in any given year. The regional trade arrangements range from Preferential Trade Arrangements, to Free Trade Areas like NAFTA, to Economic Unions like the European Union. For reasons that will become apparent when we model unions in Section 1.4, we restrict our empirical definition of unions only to those arrangements characterized by a sufficiently deep level of economic integration. In particular, we do not consider Free Trade Areas like NAFTA as a union. This is because members of Free Trade Areas may set independent tariff policies vis-a-vis non-members, making it in our view inappropriate to think about them as a block. Our empirical definition of unions therefore includes Custom Unions (no trade barriers between members, common barriers vis-a-vis non-members), Common Markets (custom unions featuring free capital and labor mobility between members), and Economic Unions (common markets featuring harmonization of economic policy, namely fiscal and monetary). We present regression results for different definitions of economic union, the results being generally robust across them.

We focus on a single cross-section of 136 countries in the year 2004. The year is the most recent one in the Baier and Bergstrand [2009] data set, and the number of countries is the maximum given the available data in 2004. We then consider all possible country pairings from this set. We assign the value of 1 to the union dummy if a particular country pair was part of a union in 2004, and 0 otherwise. [3] Given the available geographical data, we end up with 6629 country pairings.

We report in Table 1.I our estimated average marginal effects, conditional on either value for the common border dummy.

3. We treat newly-formed and continuing unions in 2004 both as instances of union formation, in line with Baier and Bergstrand [2009]. This is a caveat of our empirical analysis since, in reality, there is a likely bias towards the status-quo. That is, everything else constant, existing unions are more likely to continue than new unions to form. Unfortunately, the extremely small number of newly-formed unions in any given year prevents us from concentrating only on new unions.

Table 1.I: Wealth, inequality, and union formation

Marginal Effects on the Probability of Union Formation				
Definition of Union: at least...		...Customs Union	...Common Market	...Economic Union
Distance	adj=0	−0.038 (0.000)	−0.023 (0.000)	−0.014 (0.000)
	adj=1	−0.037 (0.000)	−0.023 (0.000)	−0.020 (0.000)
Population Size	adj=0	−0.002 (0.007)	0.004 (0.000)	0.003 (0.000)
	adj=1	−0.001 (0.688)	−0.001 (0.488)	−0.003 (0.248)
Population Inequality	adj=0	−0.006 (0.000)	−0.002 (0.042)	−0.004 (0.000)
	adj=1	−0.001 (0.795)	−0.004 (0.181)	−0.003 (0.298)
Income	adj=0	0.027 (0.000)	0.019 (0.000)	0.006 (0.001)
	adj=1	0.0002 (0.964)	0.001 (0.774)	0.0002 (0.966)
Income Inequality	adj=0	−0.026 (0.000)	−0.044 (0.000)	−0.023 (0.000)
	adj=1	−0.026 (0.015)	−0.016 (0.040)	−0.018 (0.039)
NFA	adj=0	−0.013 (0.000)	−0.010 (0.000)	−0.005 (0.000)
	adj=1	0.008 (0.153)	−0.003 (0.358)	−0.004 (0.259)
NFA Inequality	adj=0	−0.011 (0.000)	−0.005 (0.015)	−0.003 (0.091)
	adj=1	−0.004 (0.730)	−0.009 (0.177)	−0.009 (0.166)
Number of observations		6629	6629	6629
pseudo R^2		0.5413	0.5398	0.4403

Notes: Huber-White robust p-values in parenthesis, computed by the delta method.

As expected, our results support a negative effect of distance on the probability of union formation. Regarding scale, the results are somewhat inconsistent with Baier and Bergstrand [2004], in the sense that scale tends to be detrimental to union formation, except for sufficiently deep unions, and conditional on countries not sharing a common border. However, like in Baier and Bergstrand [2004], inequality in scale is generally detrimental to union formation.

We now turn to the variables that are more relevant us. The evidence supports the view that the larger the partner's combined incomes, the higher the probability of union formation, especially among non-adjacent countries. Income inequality is always clearly detrimental to union formation, and similarly for inequality in net foreign assets over GDP. The combined level of net foreign assets over GDP tends instead to detrimental for union formation, except for customs unions sharing a border. The only exception is for countries sharing a border and customs unions or deeper

arrangements.

We take these results to support the broad view that, even when controlling for geographical factors and scale effects, wealth levels contribute positively, and wealth inequality contributes negatively to union formation.

1.3 World economy

1.3.1 Model

Consider a world economy composed of a continuum of small open economies of measure one. Countries are identical ex-ante, and differ ex-post due to idiosyncratic endowment risk. Each period, a country receives an endowment of a non-storable consumption good. The endowment evolves over time according to a Markov chain with a finite number of states in the set Y. We denote by $y^t = \{y_s, y_{s+1}, \ldots, y_t\}$ the sequence of events from the initial time period $s < 0$ up to and including period t, and by $\pi(y^t)$ the probability of such sequence. The initial event $y^s = y_s$ is given and $\pi(y^s) = 1$. We denote by $\pi(y^t|y^\tau)$ the probability of y^t conditional on y^τ where $\tau \leq t$, and by $y^\tau \leq y^t$ the sequence y^τ which is a sub-root of y^t. We assume a law of large numbers holds in the cross-section of countries, which means there is no aggregate uncertainty.

Each country is populated by an infinitely-lived representative agent with preferences:

$$\sum_{t=s}^{\infty} \sum_{y^t \in Y^{t+1}} \beta^t \pi(y^t) u(c(y^t)), \tag{1.3.1}$$

where $\beta \in (0,1)$ is the subjective discount factor. The instantaneous utility u is increasing, strictly concave, and satisfies the Inada conditions: $\lim_{c \to 0} u'(c) = +\infty$ and $\lim_{c \to +\infty} u'(c) = 0$.

Countries cannot completely pool their income risk on world financial markets for two reasons. First, markets are incomplete: the menu of assets is exogenously restricted to a non-contingent one-period bond. A country's resource constraint is

$$c(y^t) + b(y^t) = y_t + (1+r) b(y^{t-1}), \tag{1.3.2}$$

where $b(y^t)$ is the demand for foreign bonds and r is the (time-invariant) world interest rate.

The second friction is that international lending contracts are imperfectly enforceable. At any

time, a country is free to repudiate its foreign debt, the penalty being the permanent exclusion from any future trade. A country that contemplates debt repudiation faces a trade-off between current and future utility: defaulting implies higher current consumption, at a cost of lower future utility due to living in autarky. International lending contracts are self-enforcing, in the sense that borrowing countries always find the cost of repudiation larger than the benefit, and they always choose to repay. That is, allocations satisfy the following participation constraint:

$$\sum_{\tau=t}^{\infty} \sum_{y^\tau \in Y^{\tau+1}} \beta^{\tau-t} \pi\left(y^\tau | y^t\right) u(c(y^\tau)) \geq V_{aut}(y^t), \tag{1.3.3}$$

where $V_{aut}(y^t)$ is the value of entering financial autarky after the history y^t. It is the lifetime utility derived from consuming one's endowment each period from the history node y^t onwards:

$$V_{aut}(y^t) = \sum_{\tau=t}^{\infty} \sum_{y^\tau \in Y^{\tau+1}} \beta^{\tau-t} \pi\left(y^\tau | y^t\right) u\left((1-\phi) y_\tau\right).$$

The parameter $\phi \in [0,1]$ is a direct output cost associated with default. Such additional default penalty has been considered in the literature, and it has been typically motivated as a way to capture production disruptions that occur because of lack of access to international markets. As in Arellano [2008], our motivation is mainly quantitative. Without such penalty, the extent of borrowing and lending in the model is much lower than in the data.

The representative agent chooses contingent plans for consumption and foreign assets to maximize lifetime utility (1.3.1) subject to the resource constraint (1.3.2), the enforcement constraint (1.3.3), and a no-Ponzi game condition:

$$b(y^t) \geq -D, \tag{1.3.4}$$

where D is large enough that the constraint never binds in equilibrium. [4]

4. Note that the enforcement constraint does not prevent countries from running Ponzi schemes: an agent running a Ponzi game would never default on its debt, since this would prevent him from continuing running the scheme.

1.3.2 Recursive competitive equilibrium

We solve for the stationary recursive competitive equilibrium with solvency constraints. The state of the economy is characterized by net foreign bond holdings b and by the current endowment y. The problem of each country admits the following recursive formulation (see Bai and Zhang [2010] for a formal proof):

$$V(b,y) = \max_{c,b'} \left\{ u(c) + \beta \sum_{y'} \pi(y'|y) V(b',y') \right\} \tag{P0}$$

subject to:

$$\begin{aligned} c + b' &= y + (1+r)b \\ b' &\geq b^W(y). \end{aligned}$$

The state-contingent borrowing constraint b^W is the debt level such that for every possible state next period, the country is weakly better-off by repaying:

$$b^W(y) = \max_{y':\pi(y'|y)>0} \left\{ b_{y'} : V\left(b_{y'}, y'\right) = V_{aut}(y') \right\}. \tag{1.3.5}$$

This constraint allows countries to borrow as much as possible while preventing them from defaulting in any possible state next period. The state- contingency arises only when there exist future states that cannot be reached from current state. We assume $\pi(y'|y) > 0$ for all y, y', so that $b^W(y) = b^W$ for all $y \in Y$.

The autarky value V_{aut} is the solution to the following functional equation:

$$V_{aut}(y) = u((1-\phi)y) + \beta \sum_{y' \in Y} \pi(y'|y) V_{aut}(y'). \tag{1.3.6}$$

Let B be the set of net foreign bond levels, $S = B \times Y$ the state-space, and $\mathscr{A}_S$ the σ-Borel algebra of elements of S. We are now ready to define the stationary recursive competitive equilibrium of the world economy.

Definition. A *stationary recursive competitive equilibrium* is given by decision rules $c(b,y)$, $b'(b,y)$,

a value function $V(b,y)$, a borrowing limit b^W, an interest rate r and a distribution $\Psi(b,y)$ of countries over S such that:

1. Given the world interest rate r and the borrowing limit b^W, the decision rules solve the recursive problem (P0) and V is the associated value function.
2. The borrowing limit b^W is not too tight, in the sense of satisfying equation (1.3.5) for all y.
3. The world credit market clears:

$$\int_S b'(b,y)d\Psi(b,y) = 0.$$

4. The decision rules and the transition matrix of the endowment process induce a probability distribution P over the state space, $P: S \times \mathscr{A}_S \longrightarrow [0,1]$, where:

$$P((b,y);A) = \sum_{y':(b'(b,y),y')\in A} \pi(y'|y)$$

is the probability of transiting from state (b,y) to a state in the set A.

5. The distribution Ψ is stationary and consistent with P:

$$\Psi(A) = \int_S P((b,y);A)d\Psi(b,y), \text{ for all } A \in \mathscr{A}_S.$$

1.3.3 Parameters and computation

Preferences are isoelastic:

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma} \tag{1.3.7}$$

with a coefficient of relative risk aversion $\sigma = 1.5$. The subjective discount factor is selected so that the equilibrium world interest rate is 1%, yielding $\beta = 0.9815$.

The direct output penalty ensures that the cross-sectional standard deviation of the net foreign asset to GDP ratio equals 0.42, the average cross-sectional standard deviation obtained from the Lane and Milesi-Ferretti [2007a] data set - we focus on a balanced panel of 110 countries over the 1970-2004 period. This yields $\phi = 0.00231$, or about a 0.2 percent yearly drop in output during default.

The endowment process is obtained from estimating the empirical first-order autoregressive process on a panel of countries:

$$\ln y_{it+1} = \mu_i + d_t + \rho \ln y_{it} + \varepsilon_{it+1},$$

where ε_{it+1} follows an i.i.d. $N(0, \sigma_\varepsilon^2)$. We include time dummies (d_t) to capture world business cycle effects. We estimate this process by pooling data on linearly detrended real output per capita from version 6.3 of the Penn World Tables [Heston, Summers, and Aten, 2009]. We focus on a balanced panel of 111 countries over the 1960-2007 period. The point estimates of the key parameters are $\rho = 0.897$ and $\sigma_\varepsilon = 0.058$. In the model we normalize every country's mean endowment to 1 and consider the common process

$$\ln y' = 0.897 \ln y + 0.058 \varepsilon',$$

with $\varepsilon' \sim$ i.i.d. $N(0,1)$. This process is discretized into a 5-state Markov chain using Rouwenhorst's (1995) procedure. The set of values for the endowment level Y and the transition matrix Π are reported in Table 1.II.

Y				
y_l	y_{lm}	y_m	y_{mh}	y_h
0.769	0.877	1.000	1.140	1.300

Π				
0.809	0.176	0.014	5×10^{-4}	7×10^{-6}
0.044	0.817	0.132	0.007	10^{-4}
0.002	0.088	0.819	0.088	0.002
10^{-4}	0.007	0.132	0.817	0.044
7×10^{-6}	0.001	0.014	0.176	0.809

Table 1.II: Markov chain parameters

We briefly describe our numerical algorithm, the full details are provided in Appendix I.3.1. The outer loop solves for the interest rate that clears the world bond market. For given interest rate, we solve for debt limit functions which are not too tight, using the natural borrowing limit as the initial guess. Finally, for given interest rate and debt limit functions, we solve for the decision rules that solve the system of first-order conditions for the country's problem.

1.4 Economic union

We now describe the process of union formation in the model. We assume the world economy is in steady-state. At time $t = 0$, and without anticipating it, a pair of countries sitting in the world economy is offered the possibility of forming a union. We pick these two countries from the ergodic state-space of the world economy's stationary equilibrium. Each country is characterized by an initial state (b_{i0}, y_{i0}), $i = 1, 2$. We also assume that union formation is a once-and-for-all event, i.e. once a union is formed it cannot be dissolved in the future.

Within the union, we assume full enforcement, and complete financial markets. [5] Since a union is comprised of a finite number of countries (in this case two), there is still some endowment risk that the union would like to diversify away with the rest of the world. We assume union members still have access to world financial markets under the same conditions as before, i.e. by trading on non-contingent bonds subject to enforcement constraints. The union is like a small country in the world economy.

We assume the existence of a central authority in the union that coordinates the international trade and default decisions. Since union members coordinate their default decisions, there is a single union-wide enforcement constraint that applies to both countries at the same time. If the union defaults, all its members are permanently excluded from world markets, but they may still share endowment risk among them.

The union's endowment is determined by the realization of two independent and identically distributed endowment processes, one for each country. We denote it compactly by a two-dimensional vector $\bar{y}_t = (y_{1t}, y_{2t}) \in Y \times Y$, where each element $y_{it} \in Y$ is country i's endowment realization, $i = 1, 2$. With a slight abuse of notation, we also denote by π the transition probabilities for $\bar{y}$:

$$\pi(\bar{y}'|\bar{y}) = \prod_{i=1}^{2} \pi\left(y_i'|y_i\right),$$

where the $\pi\left(y_i'|y_i\right)$'s are displayed in Table 1.II.

5. Note that completing markets may be achieved in a variety of ways, not just by increasing financial market sophistication. First, fiscal transfers in highly-integrated unions can achieve the same goal. Second, goods market liberalization may also complete markets. Cole and Obstfeld [1991] have shown that changes in terms of trade can go a long way towards insuring against idiosyncratic income risk; in some extreme cases trade in goods even provides all the necessary insurance, without the need for financial markets.

1.4.1 Planner's problem

The allocation within the union is constrained-efficient, and can be obtained by solving a benevolent planner's problem. Although countries join the union with potentially different net foreign bond levels, only the aggregate net asset position matters for the planner's problem. Let $\bar{b}_0 = \sum_i b_{i0}$ and let λ_i be the weight the planner attaches to country i. The planner's problem is to solve for $\{c_i(\bar{y}^t)\}_{i=1,2}$ and $\bar{b}(\bar{y}^t)$, for all $\bar{y}^t$, $t \geq 0$, which maximize the weighted sum of the union partners' lifetime expected utilities

$$\sum_{i=1}^{2} \lambda_i \sum_{t=0}^{\infty} \sum_{\bar{y}^t} \beta^t \pi(\bar{y}^t) u(c_i(\bar{y}^t))$$

subject to the union-wide resource constraint

$$\sum_i c_i(\bar{y}^t) + \bar{b}(\bar{y}^t) = \sum_i y_{it} + (1+r)\bar{b}(\bar{y}^{t-1}),$$

for all $\bar{y}^t$, $t \geq 0$, to the union-wide enforcement constraint

$$\sum_i \lambda_i \sum_{\tau=t}^{\infty} \sum_{\bar{y}^\tau} \beta^{\tau-t} \pi(\bar{y}^\tau | \bar{y}^t) u(c_i(\bar{y}^\tau)) \geq W_{aut}^U\left(\bar{y}^t\right),$$

for all $\bar{y}^t$, $t \geq 0$, where

$$W_{aut}^U(\bar{y}^t) = \max_{\{c_i(\bar{y}^\tau)\}_i} \sum_i \lambda_i \sum_{\tau=t}^{\infty} \sum_{\bar{y}^\tau | \bar{y}^t} \beta^{\tau-t} \pi(\bar{y}^\tau | \bar{y}^t) u\left(c_i(\bar{y}^\tau)\right)$$

subject to

$$\sum_i c_i(\bar{y}^\tau) = (1-\phi) \sum_i y_{i\tau}, \text{ for all } \bar{y}^\tau, \tau \geq t,$$

for all $\bar{y}^t$, $t \geq 0$, and subject also to a no-Ponzi game condition

$$\bar{b}(\bar{y}^t) \geq -D, \tag{1.4.1}$$

for all $\bar{y}^t$, $t \geq 0$.

Apart from distributional issues, the planner's problem is similar to the problem of a country standing alone in the world economy, the main difference being that, because the partners' en-

dowment processes are uncorrelated, the union faces an endowment process which is less volatile. Since markets are complete and contracts enforceable among union members, the lower aggregate endowment volatility translates into lower individual consumption volatility.

1.4.1.1 Reformulating the planner's problem

Under isoelastic preferences, the union planner's problem admits a simpler formulation which is very convenient. By Proposition 5 of Jeske [2006], aggregate borrowing and lending is independent of distributional issues. It follows that the planner's problem may be decomposed into two steps. In the first step, the planner solves for the optimal borrowing and lending of the union assuming a single representative country facing the aggregate endowment. In the second step, the planner redistributes the optimal aggregate consumption plan obtained from the first step among the two union partners.

Formally, the step 1 problem for the planner is

$$\max_{c(\bar{y}^t),b(\bar{y}^t)} \sum_{t=0}^{\infty} \sum_{\bar{y}^t} \beta^t \pi(\bar{y}^t) u(c(\bar{y}^t)) \tag{P1}$$

subject to the aggregate resource constraint

$$c(\bar{y}^t) + \bar{b}(\bar{y}^t) = \sum_{i=1}^{2} y_{it} + (1+r)\bar{b}(\bar{y}^{t-1}), \tag{1.4.2}$$

for all $\bar{y}^t$, $t \geq 0$, to the enforcement constraint

$$\sum_{\tau=t}^{\infty} \sum_{\bar{y}^\tau} \beta^{\tau-t} \pi(\bar{y}^\tau|\bar{y}^t) u(c(\bar{y}^\tau)) \geq V^U_{aut}(\bar{y}^t) \tag{1.4.3}$$

for all $\bar{y}^t$, $t \geq 0$, where

$$V^U_{aut}(\bar{y}^t) = \sum_{\tau=t}^{\infty} \sum_{\bar{y}^\tau|\bar{y}^t} \beta^{\tau-t} \pi(\bar{y}^\tau|\bar{y}^t) u\left((1-\phi)\sum_i y_{i\tau}\right),$$

for all $\bar{y}^t$, $t \geq 0$, and to the no-Ponzi game condition (1.4.1).

Given the optimal plan $c(\bar{y}^t)$ from step 1, step 2 solves for the optimal distribution of aggregate

consumption among the union partners. Formally, the step 2 problem is

$$\max_{\{c_i(\vec{y}^t)\}} \sum_i \lambda_i \sum_{t=0}^{\infty} \sum_{\vec{y}^t} \beta^t \pi(\vec{y}^t) u(c_i(\vec{y}^t)) \tag{P2}$$

subject to

$$\sum_i c_i(\vec{y}^t) = c(\vec{y}^t),$$

for all $\vec{y}^t$, $t \geq 0$.

With isoelastic preferences, the step 2 problem admits a simple, explicit solution. It is relatively easy to show that

$$c_i(\vec{y}^t) = \alpha_i c(\vec{y}^t) \tag{1.4.4}$$

where $\alpha_i \equiv \lambda_i^{1/\sigma} / \sum_j \lambda_j^{1/\sigma}$, for $i = 1,2$. That is, individual consumption is a constant fraction of aggregate consumption. The fraction is increasing in the country's welfare weight.

Similarly to Section 1.3.2, the step 1 planner's problem admits a recursive formulation:

$$V^U(\bar{b},\bar{y}) = \max_{c,\bar{b}'} \left\{ u(c) + \beta \sum_{\bar{y}'} \bar{\pi}(\bar{y}'|\bar{y}) V^U(\bar{b}',\bar{y}') \right\} \tag{P1$'$}$$

subject to

$$\begin{aligned} c + \bar{b}' &= \sum_i y_i + (1+r)\bar{b} \\ \bar{b}' &\geq \bar{b}^U(\bar{y}) \end{aligned}$$

where

$$\bar{b}^U(\bar{y}) = \max_{\bar{y}':\bar{\pi}(\bar{y}'|\bar{y})>0} \left\{ b_{\bar{y}'} : V^U\left(b_{\bar{y}'},\bar{y}'\right) = V^U_{aut}(\bar{y}') \right\} \tag{1.4.5}$$

and where $V^U_{aut}(\bar{y})$ solves

$$V^U_{aut}(\bar{y}) = u\left((1-\phi)\sum_i y_i\right) + \beta \sum_{\bar{y}'} \pi(\bar{y}'|\bar{y}) V^U_{aut}(\bar{y}').$$

Given (1.4.4), the value for country i of belonging to a union with country j is

$$V_i^U(\bar{b},\bar{y}) = \alpha_i^{1-\sigma} V^U(\bar{b},\bar{y}). \tag{1.4.6}$$

1.4.2 Competitive equilibrium

To perform our welfare analysis, we still need to recover the planner's welfare weights as a function of the initial pair of union partner states.

We use Negishi's (1960) iterative method to compute these welfare weights. This well-known method exploits the first welfare theorem, which allows us to obtain the competitive equilibrium allocation as the solution to the planner's problem for a given set of welfare weights. By requiring that the planner's allocation be affordable under the equilibrium prices, we obtain the unique pair of welfare weights that lead to the competitive equilibrium allocation associated with a given set of initial states.

We need to consider a decentralization of the constrained efficient allocation. We consider a competitive equilibrium with tax subsidies, in line with Wright [2006]. The decentralization works as follows. Within the union, countries trade a complete set of Arrow securities. In world credit markets, they trade freely on non-contingent bonds. However, a central government authority in the union taxes each country's income in a lump-sum fashion, and uses the proceeds to subsidize asset purchases. The government's tax and transfer policy is designed to support the constrained-efficient allocation. A subsidy is required to encourage union partners to save in those states when they would be inclined to default. Our procedure is described in more detail in Appendix I.2.

1.4.3 Discussion

Several features of union formation in our model are worth discussing. The role of initial conditions when computing the welfare gains from financial market integration is a crucial feature of our analysis. Whether a country is rich or poor at the time of union formation is a key determinant of the sign of the welfare gains. In the international risk-sharing literature, the role of initial conditions has sometimes been sidestepped [Athanasoulis and van Wincoop, 2000, Cole and Obstfeld, 1991, van Wincoop, 1999, either impose symmetry, or look at a representative country], whereas in other papers [Imbs and Mauro, 2007, Lewis, 2000, Wincoop, 1994] it is allowed to play a role.

Differently from this literature, however, in our model union formation may entail a welfare loss. This generates the potential for disagreement about union formation. We exploit this by requiring that unions be formed only when both partners experience a welfare gain, given the initial conditions set in the world economy. That is, union formation in our model requires unanimity.

For a large set of country pairs in our model, unions only lead to potential Pareto improvements, with one country loosing. This raises the possibility of introducing *side payments* to compensate the losers. Our analysis abstracts from such transfer schemes. In our setup, wealth would need to be redistributed away from poor and toward rich partners. We suspect the implementation of such schemes would face strong opposition in poor countries. Moreover, we do not have evidence from actual integration arrangements suggesting such schemes have taken place. [6] Finally, we believe it is more appropriate to focus our analysis strictly on the benefits from risk-sharing, separately from side-payments.

Rather than implementing a pure transfer scheme, the two partners could instead agree ex-ante on distorting the baseline union allocation, tilting it to the benefit of rich partners. Formally, one would impose *participation constraints at the time of union formation*, such that every partner may potentially benefit from it. This would increase the likelihood of union formation among heterogeneous partners, at the expense of future risk-sharing benefits. Presumably, such arrangement would be easier to implement compared to a pure transfer scheme. We think it would be very interesting to extend our analysis along this dimension. We still prefer to focus on the strict benefits from risk-sharing in this paper, and consider the role of initial participation constraints and their implementation in future research. [7]

We considered unions with *centralized international trade and default decisions*. An alternative setting is one in which each individual member country unilaterally decides whether to default. Jeske [2006] provides an analysis of this situation. As Section 1.4.1 makes clear, a major advantage of our centralized setting is analytical convenience, since it does not require solving directly for the market allocation. Note however that with decentralized default, potentially defaulting union members presume continued indirect access to world markets, by using the remaining non-defaulting

6. In the European Union, the Cohesion Fund is a transfer scheme that takes the exact opposite form: resources are transferred from rich to poor members.

7. From a technical standpoint, we would have to develop a different decentralization of the constrained-efficient allocation, to deal with the participation constraints.

members as intermediaries. This increases the incentives to default, and therefore tightens borrowing limits within the union relative to centralized default. All else constant, union formation is thus even less likely under decentralized compared to centralized default. Our analysis can be thought of as giving the best chance for union formation.

For tractability, our analysis restricts attention to *two-country unions*. In our model, since endowment risk is purely idiosyncratic, additional partners would be potentially beneficial to the union since they would further enhance risk-sharing opportunities. However, solving the frictions among union members is also likely to become more difficult and costly as the number of partners increases. This is precisely the starting premise of our paper, that solving frictions is easier at a smaller scale. Our model could be extended by introducing a cost of union formation that is increasing with the number of countries. [8] Such a setting would deliver implications for both the number and the type of countries most likely to form a union. We leave the analysis of these interesting implications to future research.

Finally, a country pair contemplating union formation is given a take-it-or-leave choice at time 0. If the union is formed, it is assumed to be forever enforced. Our analysis abstracts away from the important issue of sustainability of the economic union. Although *union breakups* are very rare in the data, they can be ex-post optimal in our model, depending on the endowment realization. Without an enforcement technology, sustaining the union would require distorting the optimal allocation, to ensure that the relevant ex-post participation constraints are met. In some cases this might not be possible, leading to a breakup of the union. See Fuchs and Lippi [2006] for an analysis of the sustainability of monetary unions with some of these features.

1.5 Results

Our goal is to characterize which country pairs find it individually rational to form a union. The main benefit of union formation is the possibility of sharing risk with a partner. There are also costs, however. First, default becomes more attractive for union members, since they may still share risk upon default. As a result, borrowing constraints are tighter in the union. In our

8. Imbs and Mauro [2007] find that, regarding benefit side alone, most risk-sharing gains would be achievable in unions of seven member-countries or less. Further, in our model it is difficult for a large number of countries to all agree about union formation. This suggests that even very small costs would be sufficient to generate to small-scale arrangements.

benchmark calibration, the borrowing limit increases from $b_i^W = -0.302$ in the world economy, to $\bar{b}_i^U = \bar{b}^U/2 = -0.235$ in the union, on a per country basis.

Second, in asymmetric unions, poorer country members tend to borrow heavily from the rest of the world, and exhaust the whole union's borrowing limit. This creates a negative externality for richer countries, which find themselves more frequently borrowing-constrained compared to standing alone in the world economy. Although being part of an asymmetric union tends to be beneficial for poorer members, it also tends to generate losses for richer countries. Our model will therefore produce a bias against forming asymmetric unions.

We now turn to a more detailed analysis of union formation. We compute the welfare gain for each country of forming a union with a specific partner in terms of consumption equivalents. That is, as the percentage increase in consumption, constant across time and states of nature, that leaves the country indifferent between standing alone in the world economy and forming the union.

Consider two countries sitting in the world economy at time 0, with states (b_{i0}, y_{i0}), $i = 1, 2$. If they form a union, the initial aggregate state is $(\bar{b}_0, \bar{y}_0)$, with $\bar{b}_0 = b_{10} + b_{20}$ and $\bar{y}_0 = (y_{10}, y_{20})$. Let $c^W(b_{i0}, y_{i0})$ represent a state-contingent consumption stream for country i in the world economy, from state (b_{i0}, y_{i0}) onwards. Let $c_i^U\left(\bar{b}_0, \bar{y}_0\right)$ represent a state-contingent consumption stream for country i if both countries decide to form a union at time 0. Let $U(c^W(b_{i0}, y_{i0}))$ and $U\left(c_i^U\left(\bar{b}_0, \bar{y}_0\right)\right)$ denote the expected lifetime utility derived from these consumption streams. Now denote by $(1+\mu_{ij})c^W(b_{i0}, y_{i0})$ the consumption stream derived from $c_i^W(b_{i0}, y_{i0})$, where every state-contingent consumption level is increased by μ_i percent. The welfare gain for country i of forming a union with country j is the μ_{ij} that solves:

$$U\left((1+\mu_{ij})c^W(b_{i0}, y_{i0})\right) = U\left(c_i^U\left(\bar{b}_0, \bar{y}_0\right)\right),$$

or, with isoelastic preferences as in (1.3.7),

$$\begin{aligned} \mu_{ij} &= \left[\frac{U\left(c_i^U\left(\bar{b}_0, \bar{y}_0\right)\right)}{U\left(c^W(b_{i0}, y_{i0})\right)}\right]^{\frac{1}{1-\sigma}} - 1 \\ &= \left[\frac{V_i^U\left(\bar{b}_0, \bar{y}_0\right)}{V(b_{i0}, y_{i0})}\right]^{\frac{1}{1-\sigma}} - 1, \end{aligned} \tag{1.5.1}$$

where the value functions have been defined in (P0) and (1.4.6). Notice that our welfare numbers incorporate transitional dynamics.

We next study the separate roles of wealth heterogeneity and wealth levels for union formation.

1.5.1 Role of wealth heterogeneity

Figure 1.1 displays the welfare gain for country 1 of forming a union, as a function of country 1 and country 2's initial net foreign asset levels. The figure is conditional on both countries starting the union formation process with mid-level endowment, y_m. Union partners are heterogenous only in terms of initial debt levels.

Several observations emerge from Figure 1.1. First, country 1 experiences a welfare loss for a large range of net foreign asset levels. The equilibrium welfare gains range from -1.4% to 3.7%, with a mean of 0.5%. These are low welfare gains from union formation. Comparing with the literature on the welfare gains from international risk-sharing, the average gain is similar to the values in the lower end of the range, as summarized by van Wincoop [1999], and in line with those obtained by Cole and Obstfeld [1991], Backus, Kehoe, and Kydland [1992], Obstfeld [1994b], Tesar [1995], and Mendoza [1995].

Second, Figure 1.1 shows that country 1's welfare gain is always increasing in the partner's net foreign assets. Third, country 1's welfare gain is increasing in own net foreign assets only if the partner's is sufficiently low;[9] otherwise, if the partner is rich, the welfare gain is monotonically decreasing in own net foreign assets. Put together, the last two observations suggest the key determinant for union formation is the amount of the resources the partner has: a country would like to belong to a rich club, especially if it's poor.

Figure 1.2 displays the agreement areas, i.e. the set of initial country states for which both countries would experience a welfare gain, and thus agree to form a union. Figure 1.2 is restricted to endowment levels in $\{y_l, y_m, y_h\}$. For states above the solid lines, country 1 would improve welfare by forming a union with country 2, and similarly for country 2 for states below the dashed lines. The agreement areas are therefore represented by the light-shaded areas.

Superimposed on Figure 1.2 is also an area representing the ergodic space for net foreign

9. Although not apparent from the Figure 1.1, the welfare gain is actually non-monotonic in own net foreign assets if the partner's is low enough.

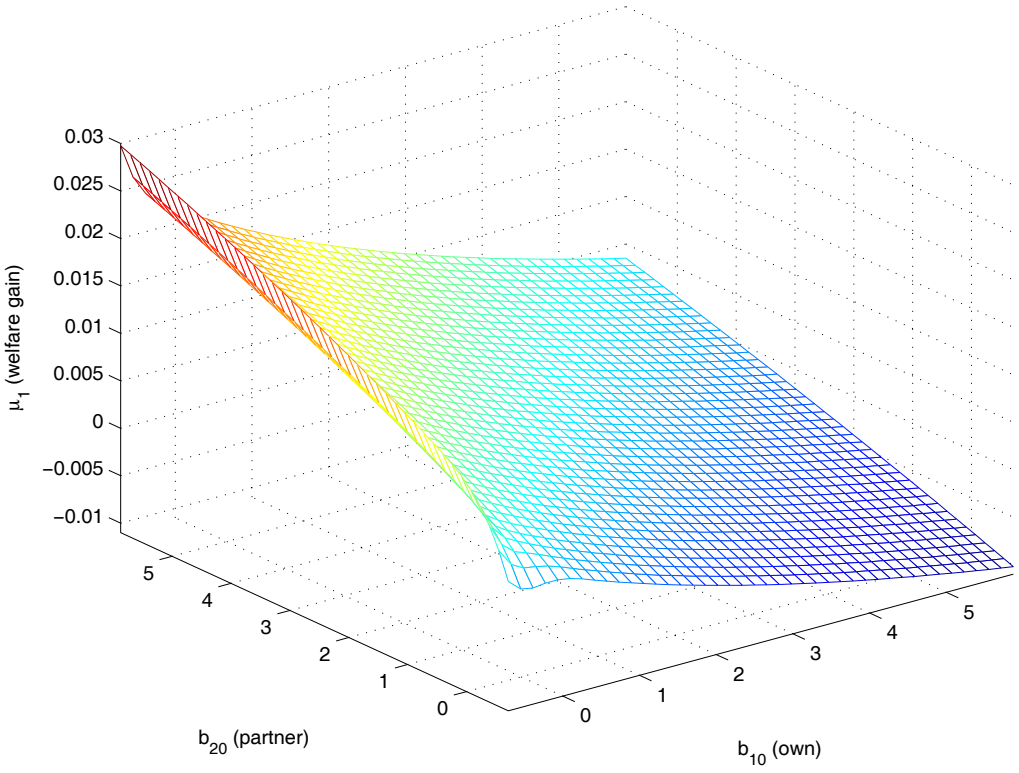


Figure 1.1: Welfare gain from union formation

asset positions in the world economy, $b_{10}, b_{20} \in [-0.302, 3.869]$.[10] This is the dashed square located inside each figure. Notice the role played by the world equilibrium in our analysis of union formation. It determines both the world interest rate faced by the union, and also the relevant subset of country pairs that are faced with the option union formation.

We begin with the first row of Figure 1.2. In this row, potential union members have identical initial endowments, but potentially different wealth levels. The figure shows, first, that unions tend to be formed between countries sufficiently homogeneous in terms of initial wealth. Along the 45 degree line, and restricted to the ergodic space, countries always reach an agreement. The disagreement area exists when wealth levels are sufficiently different from each other. Second, we also see that whenever partners disagree, the rich are the ones with a potential welfare loss. They are the ones preventing union formation.

Turning now to the bottom row of Figure 1.2, which corresponds to asymmetric initial endowments, we see that endowment heterogeneity makes it nearly impossible for countries to agree to

10. Since the average endowment is equal to 1, these quantities correspond also to net foreign assets to average output ratios.

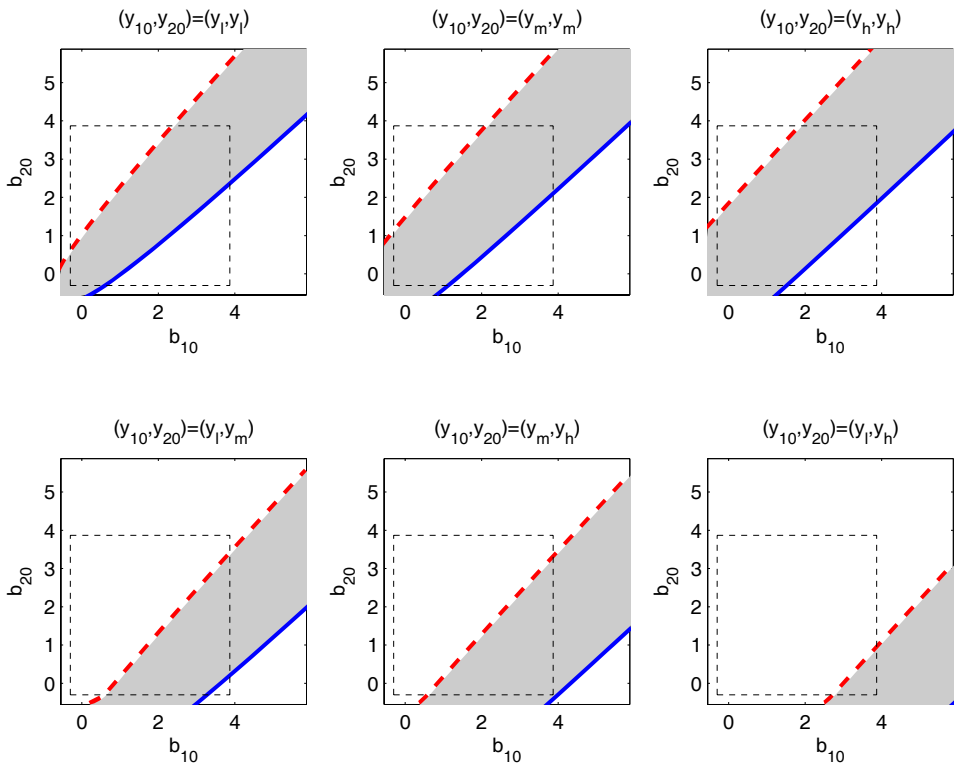


Figure 1.2: Agreement areas (country 1: solid, country 2: dashed)

form a union. Indeed, restricting to heterogeneous endowment levels in $\{y_l, y_m, y_h\}$, an agreement is never reached. Although country 1, the endowment-poor country, would always benefit from union formation (the ergodic space is always above the solid line), this is not the case for country 2, the endowment-rich country. Only a sufficiently asset-poor country 2 would like to form a union with an endowment-poor country 1. This effect is less dramatic the less asymmetric the initial endowment levels are. For example, some agreements may be supported with $(y_{10}, y_{20}) = (y_{mh}, y_h)$, depending on the initial net foreign asset levels.

The bottom line is that country homogeneity, either in terms of net foreign assets or endowments, is a key determinant of union formation. Unions are more likely to form among similar countries. The key mechanism underlying partner disagreement is the effect the union generates on the probability of becoming constrained in the future.

To better understand this mechanism we turn to Figure 1.3. This figure displays the difference between the probability of becoming credit-constrained in a union and the probability of becoming credit-constrained while standing alone in the world economy, during the first 100 periods start-

ing from today.[11] This is computed for each initial level of net foreign assets of the reference country (labeled "own" in the figure) and of any given potential union partner, conditional on the endowment being equal to y^h for country 1 (relatively rich) and y^m for country 2 (relatively poor).

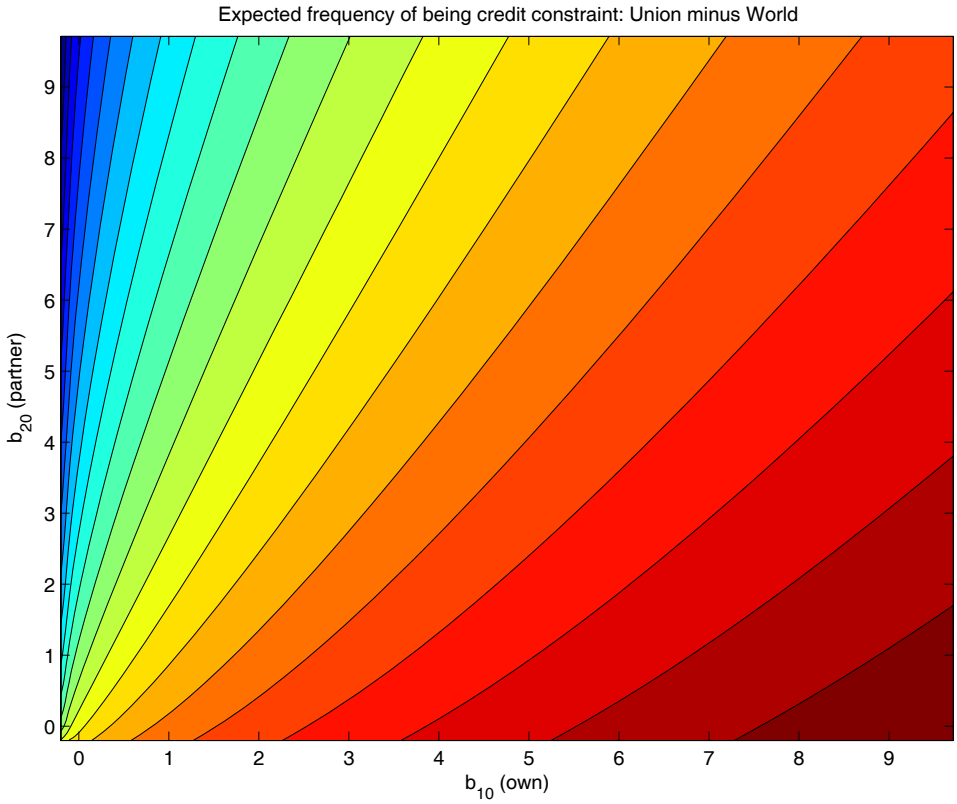


Figure 1.3: Excess probability of becoming credit constrained in the union

Several observations emerge. First, the excess probability is negative for a large set of states. This is in spite of tighter borrowing limits in the union: countries are better insured in the union, hence borrow less in world credit markets and hit the constraint less often compared to standing alone. Second, the excess probability becomes more negative when the reference country is poorer and the partner richer. Third, the excess probability becomes positive when the reference country is richer and the partner poorer. These are precisely the areas of disagreement we identified earlier, illustrating the importance of our mechanism: asymmetric unions benefit poor countries at the expense of rich, via changes in the likelihood of becoming credit-constrained following union formation.

11. Our focus on the short run stems from the fact that we wish to understand the welfare comparisons underlying Figure 1.2, and individuals obviously discount the future. The excess probability in Figure 1.3 is in percentage points.

1.5.2 Role of wealth levels

We now turn to the role of wealth (net foreign assets plus endowment) levels. From the first row of Figure 1.2, we see that a larger union-wide endowment favors union formation. First because, as we move from the left to the right panel, the agreement area fills a larger area of the ergodic space. Second because the agreement areas get wider for larger wealth levels, which is particularly noticeable when conditional on (y_l, y_l).

Figure 1.3 once again helps us understand the basic mechanism. As we move along any line starting from the lower left corner of the figure, the excess probability that country 1 becomes credit-constrained in the union decreases. When both partners are richer they are farther away from their borrowing constraints, and are thus less likely to face the type of disagreement that we illustrated in the previous section.

We summarize the discussion of this and the previous subsection with the following. Unions are more likely to be formed:

1. the wealthier the partners, and
2. the more homogeneous the partners,

either in terms of initial endowment or net foreign assets. Quantitatively, the most important determinant of union formation appears to be partner homogeneity.

1.5.3 Quantitative implications

To explore the quantitative implications of the model, we compute the probability of union formation conditional on different regions of the state-space. [12] We ask: What is the probability that two randomly-picked countries from particular subsets of the world distribution agree to form a union?

In selecting subsets of the ergodic space, we focus on the top and bottom terciles for output (respectively defined as $Y_h = [y_{2/3}, y_{\max}]$ and $Y_l = [y_{\min}, y_{1/3}]$) and net foreign-assets over GDP (respectively defined as $B_h = [(b/y)_{2/3}, (b/y)_{\max}]$ and $B_l = [(b/y)_{\min}, (b/y)_{1/3}]$). We define such

12. An alternative procedure would be to run a probit-gravity regression on artificial data which would be the exact analogue of the one in Section 1.2, except that the terms involving geography and scale would be excluded. Unfortunately, due the nonlinear nature of the regression model, the marginal effects would be hard to compare. They would be a function not only of the estimated parameters, but also of the data itself (actual vs artificial).

sets in the exact same way both in the actual data and in the model. Since the results are similar across our empirical definitions of unions, in the actual data we restrict attention to customs unions or deeper arrangements.

We restrict attention to only three subsets, with the aim of capturing the key implications we drew from Figure 1.2. More specifically, take country pairs defined by their current output and net foreign assets over GDP. [13] We consider “Rich" country pairs (both in the set $Y_h \times B_h$), “Poor" country pairs (both in the set $Y_l \times B_l$), and “Unequal" country pairs (one in the set $Y_h \times B_h$ and the other in $Y_l \times B_l$). We also compute the “Unconditional" probability of unions formation.

	Data	Data, common border	Model
Rich	16%	71%	68%
Poor	8%	20%	43%
Unequal	0%	0%	5%
Unconditional	4%	32%	40%

Table 1.III: Conditional Probabilities of Union Formation

Our results are summarized in Table 1.III. The first column pertains to the entire data set. Only 4% of all country pairs are part of a customs union or deeper arrangements. This number is 8% conditional on poor country pairs, and 16% conditional on rich country pairs. The data does not feature unions among unequal pairs.

The second column repeats these calculations restricting to country pairs sharing a common border. The results are qualitatively similar, but the conditional probabilities of union formation are now much higher. The conditional probabilities in the model are in the third column. They are reasonably close to the empirical probabilities conditional on countries sharing a common border. Since our model abstracts from geography as a determinant of union formation, we find it more appropriate to compare the model’s implications to the data restricted to common border countries. The main discrepancy is that our model implies low wealth levels are not as detrimental to union formation compared to the data. Poor countries in the model are twice as likely to form a union compared with the data.

13. For the reasons explained in Section 1.2, by “current" levels we actually mean five-year averages.

We conclude that our model seems to provide a reasonably accurate description of the incentives for union formation, namely the role of wealth levels and wealth inequality.

1.6 The European Union: a short digression

There are two aspects of the European Union experience which appear to be consistent with our model. First, the successive accession waves happened after an important degree of income convergence has taken place between accessing and member countries. Our model says that this is an important condition for union formation. Figure 1.4 illustrates this fact.[14] The left panel represents the accession of Greece in 1981, and Portugal and Spain in 1986. Together with the real income of the accessing countries, the figure also plots the mean real income of the countries which were members by 1980. A very significant degree of convergence has occurred before these Southern European countries joined the European Union (European Economic Community by then), in fact to a much larger extent than the degree convergence that took place afterwards. The right panel of Figure 1.4 documents the accession of the Eastern European block in 2004. All these countries without exception have experienced a significant degree of convergence before joining the European Union.

It is also important to point out that both the Southern and the Eastern European countries were able to join the European Union when they did due to the sine qua non removal of political obstacles: the Southern European countries became democracies in 1974/5, and the Eastern block around 1990. While these political considerations were obviously central, economic considerations were central too. Accessing countries were required to implement major free-market economic reforms as a condition for membership. These reforms were no doubt important for the subsequent economic performance of accessing countries; we would say also for the success and the stability of the European Union.

The second aspect of the European Union experience which seems consistent with our model is related to the current crisis involving Greece and Ireland, and to a lesser extent Portugal and Spain. All these countries became highly indebted in foreign markets in recent times, in large measure benefiting from German credibility and low interest rates. At the same time, we do not see any indication that these countries contemplate abandoning the euro area. Instead, it is the rich

14. The countries corresponding to the labels in the legend are indicated in Appendix I.

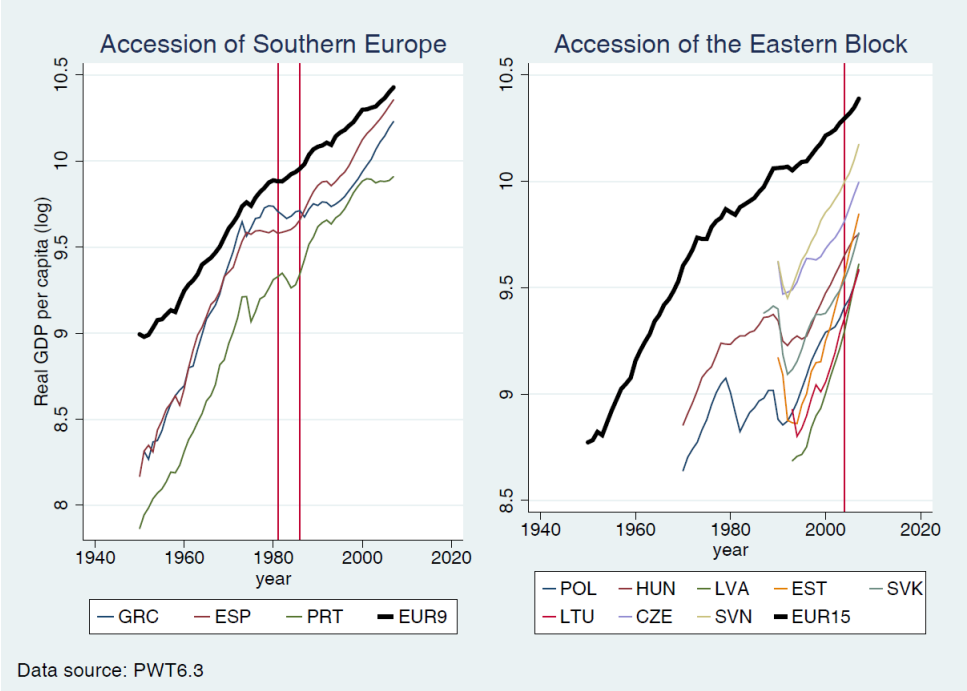


Figure 1.4: Income levels upon accession into the European Union

countries, most notably Germany, who are unhappy about providing aid to the Southern European countries. Our model predicts that poor countries borrow a lot once members of a union, and says that instability within the union would arise precisely in this form, with rich countries having a preference for breaking up.

1.7 Conclusion

We have developed a quantitative theory of economic integration based on the incentives to share income risk. We have modeled an economic union as a small-scale arrangement that solves the frictions that otherwise limit the extent of risk sharing in the world economy.

Our model emphasizes not only the risk-sharing benefits of union formation, but also its costs. One cost is that, a country that is part of a union will not be able to borrow as much as a country standing alone in the world economy. This is because unions have larger incentives to default. Another cost is for rich countries forming a union with poor countries. Poor countries tend to exhaust the whole union's credit limit, imposing a negative externality on rich countries. Our model implies that economic integration should not happen very often, and when unions do get

formed it is mostly among rich and homogeneous countries. These features appear to be consistent with real-world arrangements.

Our paper has abstracted from a host of issues that could be potentially important for union formation based on risk-sharing. In particular, we have assumed different countries are characterized by common and independent income processes. In reality, shocks tend to be correlated among subsets of countries, which would work against union formation in our model. [15] Further, there is large cross-country heterogeneity in income risk, with poorer countries being more volatile (Acemoglu and Zilibotti [1997]). In our model, this could potentially increase the likelihood of union formation among poor countries. [16] Finally, there are also differences in country size. All these issues deserve further scrutiny.

Our paper has also focused on just one particular dimension of economic integration, the sharing of risk. It would be interesting to consider other key dimensions of economic integration within small scale arrangements, namely liberalizing goods flows (Melitz [2003], Alvarez and Lucas [2007]), labor flows (Klein and Ventura [2007]), and investment flows (Castro [2005], Gourinchas and Jeanne [2009], Burstein and Monge-Naranjo [2009], McGrattan and Prescott [2009]). [17]

15. Instead, correlated shocks is traditionally emphasized as a motivation for the formation of currency unions.

16. A similar implication follows from Imbs and Mauro's (2007) analysis.

17. Further dimensions of small scale economic integration that received some attention in the recent literature include adopting a common currency (Alesina and Barro [2002]) and coordinating public policy (Alesina, Angeloni, and Etro [2005]).

CHAPITRE 2

THE CROSS-SECTIONAL DISPERSION OF NET FOREIGN ASSET POSITIONS AND INVESTMENT RATES

2.1 Introduction

The rising dispersion of external imbalances and the record-high level reached by some major economies has received considerable attention during the recent years. Chang, Kim, and Lee [2009] (hereafter CKL) reported that from 1970 to 2000, the standard deviation of the ratio of net foreign asset to GDP has increased from 29.3 to 55.4. [1] A strand of literature views the building of these imbalances as a logical outcome of the increasing integration of the world economy. [2] If the increase in the cross-sectional dispersion in NFA positions is due to the lowering of barriers to capital flows as in CKL, one would expect the dispersion in investment rate to go up as well because one fundamental reason countries borrow and lend internationally is to finance their investments needs. But evidence from the Penn World Tables [Heston, Summers, and Aten, 2009] points to the contrary : the dispersion in investment rates has declined slightly over the same period.

The goal of this paper is to understand the increase in the cross-sectional dispersion of NFA positions with a relatively stable dispersion in investment rates. [3] I undertake a quantitative analysis of the global dispersion of net foreign asset positions and investment rates. The framework is an integrated model of world economy featuring a continuum of ex-ante identical countries. They differ ex-post due to an idiosyncratic shock to their total factor productivity levels. International capital flows is restricted because of two financial imperfections. First, the menu of assets traded is exogenously restricted to a risk-free bond. Second, international lending contracts are not legally enforceable. At any time, a country may choose to repudiate its foreign debt subject to financial exclusion. I depart from CKL by modeling the reduction in the barriers to cross-country financial flows through a direct cost of exclusion. This will induce loser borrowing limit and increase the

1. See Faruqee and Lee [2009] for evidence on the rising dispersion of current account.
2. Proponents of this view include Bernanke [2005], Caballero, Farhi, and Gourinchas [2008] and Mendoza, Quadrini, and Ríos-Rull [2009].
3. Throughout the paper, the term “net foreign asset position” is used to refer to the ratio of net foreign asset to GDP.

cross-section capital flows.

The direct cost of exclusion captures all kinds of interdependence among countries that may have developed over time and increased the cost of sovereign default. As suggested by Cole and Kehoe [1997], I take the view that countries have many kinds of relationships involving trust and the debt relationships have implications for these other relationships as well. It follows that the reputation of defaulting countries can spillover to these relationships, making default more costly. Trade finance can be affected by such spillover. Borensztein and Panizza [2010] argued that sovereign default raises the possibility of the imposition of capital controls, affecting the creditworthiness of private debtors even if they do not face solvency problems. [4] Default can also destabilize the domestic financial system or discourage foreign investors and reduce FDI flows. [5] The view is that with the rapid integration of world economies that has taken place over the recent decades, countries have become inter-dependent in several aspects, thereby increasing the margins through which defaulting countries can be punished.

The model is calibrated the model to match the evolution of the global dispersion of net foreign asset positions for 1970-2004. The implications for the dispersion of investment rates are then examined. The results show that an increase in the output cost of default within the range of empirical estimates can account for the dispersion in net foreign asset positions. In addition, the model reproduces the shift of the distribution towards the borrowing side as we move from a less integrated economy to a more integrated economy. Finally, consistent with data, the model predicts a slight decline in the dispersion of investment rates.

The penalty cost of default and the capital adjustment cost are important in generating the results. On one hand, there is a mapping between the output cost of default and the borrowing limit faced by countries. As the penalty cost increases, defaulting becomes more costly and large levels of debt and assets are sustained in equilibrium. On the other hand, the adjustment cost to domestic capital accumulation tempers the response of investment to productivity shocks and severely restricts its dispersion. Although the incentives to borrow and lend internationally have increased, the incentives to invest have not changed much leading to an increased dispersion in net

4. They found evidence that export-oriented industries are hurt disproportionately by an episode of sovereign default. See also Rose [2005] for an evidence on a negative effect of debt renegotiation episodes on bilateral trade.

5. Borensztein and Panizza [2009] provided an excellent review as well as an empirical assessment of the different channels through which default can be costly for the economy of the defaulting country.

foreign asset positions with a relatively stable dispersion in investment rates.

This paper is related to several strands of literature. It contributes to the literature associating the phenomenon of global imbalances to the easing of financial imperfections. Exploring different trade frictions, CKL found that a spread of 3 percent between the borrowing and lending rates can account for the evolution of the global dispersion of current account balances and net foreign asset positions over the last three decades. [6] Such spread discourages countries from frequent borrowing and induces them to save, reducing the dispersion in external imbalances. However, this generates stationary distributions of imbalances that are perfectly symmetric and hard to reconcile with the data. I depart from their paper in two key aspects. First, they consider an endowment economy and the emphasis on risk sharing and consumption smoothing. By considering a production economy, I take into account another major motive for international capital flows : investment. The second departure is that financial frictions are endogenous. The borrowing constraint is not exogenous but emerges endogenously from the incentives countries have to repudiate their debt. An increase in the penalty cost reduces those incentives to default and relaxes the debt limit.

Mendoza, Quadrini, and Ríos-Rull [2009] emphasize the role of heterogeneity in domestic financial systems in generating imbalances. They argued that if countries have different levels of financial development, financial integration can lead countries with deeper markets to build external liabilities, typically by investing in risky assets and financing their investment needs with external borrowing. Therefore, the model accounts for the composition of net foreign asset positions and the direction of capital flows. [7] However, the focus here is on the dispersion of net foreign asset positions.

This paper also relates to the literature employing quantitative dynamic general stochastic equilibrium models to study development regularities, in particular differences in investment rates across countries. Restuccia and Urrutia [2001] investigated the role of barriers to investment in accounting for the dispersion in relative investment rates as well as the decline of such dispersion over the period of 1960-1985. Using data from the Penn World Tables, they map barriers to investment to the relative price of investment to consumption goods and found that the model could explain as much as 90 percent of the 1985 Gini in relative investment rates. Their model is however

6. They also considered trade balances.

7. See also Caballero, Farhi, and Gourinchas [2008] for a model emphasizing heterogeneity in domestic financial system, where countries differ in their capacity to generate financial assets from real investments.

a world composed of a collection of closed economy and there is no international capital flows. In an open-economy setup similar to the one in this paper but with ad hoc borrowing constraints, Castro [2005] investigated the role of productivity differences in explaining a set of development facts related to capital accumulation, including the dispersion in investment rates.

The rest of the paper is organized as follows : the next section presents the empirical evidence that motivates the study. Section 3 lays out the theoretical model and defines the competitive equilibrium. Section 4 describes the calibration and the computational procedure. Section 5 presents the findings and section 6 concludes.

2.2 Evidence

This section presents some evidence pertaining to the distribution of net foreign asset positions and investment rates over the period of 1970-2004. It is based on data from various sources. Data on net foreign assets is from the updated and extended "External Wealth of Nations" data set (EWN II) constructed by Lane and Milesi-Ferretti [2007a]. Net foreign assets are defined as the difference between total asset and liabilities. [8] Investment rates correspond to investment as a share of real GDP and are from the version 6.3 of the Penn World Tables [Heston, Summers, and Aten, 2009]. A more detailed description of the datasets is provided in the appendix II.1. I emphasize the following three facts :

Fact 1 The cross-sectional dispersion of net foreign asset positions has increased over time.

2.2(a) shows the evolution of the distribution of net foreign asset positions from 1970-1974 to 2000-2004. I take 5-year averages in order to abstract from any short-term fluctuations. I also abstract from the effect of countries with exceptionally large imbalances by excluding from the sample countries in the top and bottom deciles of the distribution. [9] The top panel of the figure shows that during 1970-1974, the majority of countries had net foreign asset positions that were negative and comprised between 0 and 25 percent of their GDP. In 2000-2004, this proportion has dropped to 24 percent. The mass of the distribution has shifted toward the tails, mostly on the

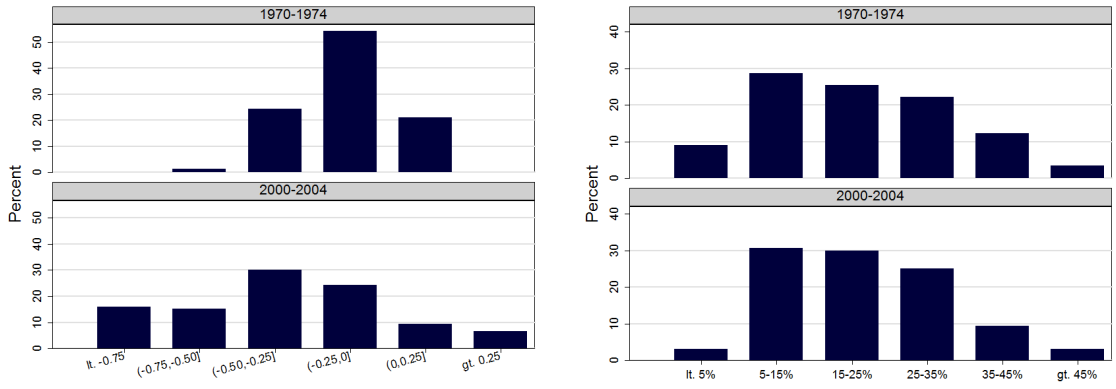
8. Assets and liabilities include the following types of instruments : FDI, portfolio equity, debt and derivatives. External assets also include foreign exchange reserves (excluding gold).

9. The figure is therefore based on countries with net foreign asset positions comprised within the 80 percent range. We are left with 91 and 140 countries respectively for the period of 1970-1974 and 2000-2004.

borrowing side. For example, more than 30 percent of countries held negative net foreign asset positions that are higher than 50 percent of their GDP in 2000-2004 compared to 1 percent in 1970-1974.

This dispersion is quantified in table 2.I which reports together with other summary statistics, the cross-sectional standard deviation of net foreign asset positions. It shows that the standard deviation has more than doubled, increasing from 0.17 in 1970-1974 to 0.39 in 2000-2004. This evidence has also been documented by Lane and Milesi-Ferretti [2007b] in the case of some major industrial countries and by CKL for a larger sample over the period of 1960-2000. [10]

Figure 2.1 – Evolution of the distribution of NFA positions and investment rates, 1970-2005



(a) Net foreign asset positions

(b) Investment rates

Fact 2 The median (and mean) value of the distribution has gone down.

The distribution of net foreign asset positions has shifted to the left. Table 2.I shows that the median of the distribution has moved from -0.14 in 1970-1974 to -0.43 in 2000-2004. The evolution of the mean of the distribution followed the same pattern. The widening of the 80 percent range was also more pronounced on the borrowing side than on the lending side, resulting in even more mass on the borrowing side than on the lending side. For instance, for 2000-2004, there are about 40 percent of countries with net foreign asset positions that are negative and comprised within the range of 25 to 75 percent of their GDP. More than 20 percent of countries have net external

10. Lane and Milesi-Ferretti [2007b] analyzed the dispersion of net foreign asset positions of some major creditors and debtor countries over a shorter period of time, and discussed some factors that can explain such dynamics.

positions that are negative and above 75 percent of their GDP. This contrasts with the fact that less than 10 percent have NFA positions that are positive and above 25 percent of their GDP.

Lane and Milesi-Ferretti [2007a] documented a discrepancy in the data on net foreign asset and one can think that it explains this asymmetry. They found that the discrepancy has been on an upward trend and represented a liability of 5 percent of world GDP in 2004. They attributed it to the underreporting of foreign assets. However, looking at the distribution of the ratio of net foreign assets to GDP, there are other factors that can explain the asymmetry. One of such factors is an asymmetry between lenders and borrowers on the financial markets. Contrary to lenders, borrowers usually cannot borrow as much as they want because of various kinds of financial frictions. As a consequence, large external asset positions will be more common than large liabilities and there will be a larger mass of countries on the borrowing side than on the lending side. [11]

Tableau 2.I – Summary statistics : NFA positions and investment rates

	NFA positions		Investment rates	
Statistics	1970-1974	2000-2004	1970-1974	2000-2004
Mean	-0.14	-0.48	0.21	0.20
Median	-0.15	-0.43	0.19	0.21
Min	-0.50	-1.44	0.02	0.03
Max	0.19	0.36	0.51	0.73
Standard. deviation[a]	0.17	0.39	0.75	0.64
Coeff. of Variation	-1.15	-0.80	0.59	0.55
Gini index	NA	NA	0.33	0.30

[a] The standard deviation for investment rates is for the log while that for net foreign asset positions is for the level.

Fact 3 The dispersion in real investment rates has declined slightly.

This evolution of the dispersion of net foreign asset positions contrasts with that of investment rates. Table 2.I reports three measures for the dispersion of investment rates : the standard deviation calculated from the logs, the coefficient of variation and the Gini index. All these measures point to a decline in the dispersion of investment rates. For instance, the coefficient of variation declined

11. The distribution of the GDP and its relation with external positions can also affect the shape of the distribution of the ratio. For example, if there is a positive relationship between net foreign asset levels and income levels, scaling the net foreign asset with GDP will tend to spread the distribution on the borrowing side and condense it on the lending side.

by 6.8 percent, from 0.59 to 0.55. However, this decline is not very big and additional evidence reported in figure II.2(b) shows that it took place mainly between 1970 and 1980. Based on this, I conclude that overall, the dispersion in investment rates declined very slightly.

Looking at figure 2.2(b), this decline in the dispersion is barely noticeable. The figure presents the evolution of the distribution of investment rates between 1970-1974 and 2000-2004. To ensure consistency, it is based on the same sample of countries as the one used for the distribution of NFA positions. It shows that the mass of the distribution of investment rates has moved slightly from the tails toward the mean. For instance, the fraction of countries with investment rates between 15 and 25 percent of their GDP has increased from 25 percent in 1970-1974 to 30 percent in 2000-2004. At the same time, the fraction of countries with investment rates below 5 percent of their GDP has dropped from nearly 10 to 3 percent over the same period. The decline in the dispersion of investment rates has also been highlighted in Restuccia and Urrutia [2001]. They found that over the period of 1960-1985, the Gini coefficient for relative investment rates has decreased from 0.37 to 0.30.

CKL relaxed financial frictions to explain the rising dispersion of external imbalances (fact 1). One could think that the easing in financial frictions would increase the dispersion in investment rates as well (fact 3). In the next section, I will reconcile these facts in a quantitative model of world economy.

2.3 The model

Given the cross-section nature of the evidence, a multi-country model is in order. Following Clarida [1990], I consider a world economy with a continuum of small open economies subject to idiosyncratic productivity shocks. There is no aggregate uncertainty. On world financial markets, financial frictions prevent countries from full risk sharing.

2.3.1 The country problem

Each country is populated by a constant and large number of identical and infinitely lived agents. Countries are identical ex-ante. However, they differ ex-post due to an idiosyncratic productivity shock z_t affecting their Total Factor Productivity (TFP) levels. I assume that z_t evolves

over time according to a Markov chain that takes values in a finite set Z. I denote by z^t the history of events up to, and including period t : $z^t = (z_0, \ldots, z_t)$, and $\pi(z^t)$, the date 0 probability of such sequence of events. The representative agent has preferences over :

$$\sum_{t=0}^{\infty} \sum_{z^t \in Z^{t+1}} \beta^t \pi(z^t) u(c(z^t)) \tag{2.3.1}$$

where $c(z^t)$ is the consumption at history node z^t, and $0 < \beta < 1$ is the subjective discount factor. Instantaneous utility u is increasing, strictly concave and satisfies the Inada conditions : $u(0) = 0$, $\lim_{c \to 0} u'(c) = +\infty$ and $\lim_{c \to +\infty} u'(c) = 0$.

In each economy, the representative firm produces output by combining capital and labor according to a Cobb-Douglas technology. Leisure is not valued and the representative agent supplies inelastically all his labor - normalized to one - to the firm. Since population is constant, per capita output is given by :

$$y_t = z_t k\left(z^{t-1}\right)^{\alpha} \tag{2.3.2}$$

where $k(z^{t-1})$ is the per capita stock of capital brought into history node z^t and α is the capital share. Capital accumulates through old capital stock that depreciates at a rate δ and new investment $i(z^t)$:

$$k(z^t) = (1-\delta)k(z^{t-1}) + i(z^t) \tag{2.3.3}$$

Changes to capital stock are costly. Accumulation of physical capital is subject to a standard convex adjustment cost common to all countries :

$$\psi\left(k\left(z^{t-1}\right), k(z^t)\right) = \phi\left[\frac{k(z^t)}{k\left(z^{t-1}\right)} - (1-\delta)\right]^2 k\left(z^{t-1}\right) \tag{2.3.4}$$

where ϕ is a parameter that governs the size of the adjustment cost. With this specification, there is no cost in maintaining the current capital stock ($\psi(k, \delta k) = 0$). However, changes are costly : the larger the change to current capital stock, the larger the cost.

Countries cannot pool their idiosyncratic risk on the international financial markets because of two reasons : world financial markets are incomplete and contracts suffer from the default risk.

The menu of assets available on world financial markets is exogenously restricted to a one-period risk-free asset. In the model there is no aggregate shock and the world's interest rate is constant. Combining equation (2.3.2), (2.3.3) and (2.3.4), the aggregate resources constraint of the economy is :

$$c\left(z^t\right)+i(z^t)+\psi\left(k(z^{t-1}),i(z^t)\right)+b\left(z^t\right)=z_t k\left(z^{t-1}\right)^{\alpha}+(1+r)\,b\left(z^{t-1}\right) \tag{2.3.5}$$

where $b(z^t)$ is the demand for foreign bond and r is the time-invariant world interest rate.

The second friction is that international borrowing and lending suffers from default risk. At any time, a country is free to repudiate its foreign debt and enjoy a higher level of consumption in the current period. However, this is costly : a defaulting country is permanently excluded from any future financial trade and experiences a permanent drop in the output level. A country contemplating default compares these costs to the benefit of higher current consumption.

Although only a single bond is traded, participation in the world financial markets is attractive for several reasons. Contrary to domestic capital, foreign bond is risk-free and provides countries with an opportunity to reach their desired investment level without having to cut down on current consumption. In addition, because of the decreasing return to scale and the general equilibrium effect, it provides a higher return on savings compared to domestic capital for countries with large capital stocks. Finally, it allows countries to avoid the cost of large capital adjustments : countries can spread large capital adjustments over several periods by using foreign assets as a buffer stock to save extra resources for future investment or borrow additional resources to supplement current consumption.

In the model, there is no information asymmetry. Lending contracts are self-enforcing in the sense that a country will never be able to borrow an amount such that it may be profitable for him to default. At any history node z^t, the resulting constrained efficient allocation satisfies the following incentive compatible constraint for all possible future states z_{t+1} in the next period :

$$\sum_{\tau=t+1}^{\infty}\sum_{z^\tau\succeq Z^{t+1}}\beta^{\tau-t}\pi(z^\tau|z^t)u(c(z^\tau))\geq V^{aut}\left(k\left(z^t\right),z_{t+1}\right) \tag{2.3.6}$$

where $V^{aut}\left(k\left(z^t\right),z_{t+1}\right)$ is the value of financial autarky. It is solution to :

$$V^{aut}\left(k\left(z^{t-1}\right),z_t\right)=\max_{c(z^t),k(z^t)}\left\{u\left(c(z^t)\right)+\beta\sum_{z'}\pi\left(z_{t+1}|z_t\right)V^{aut}\left(k\left(z^t\right),z_{t+1}\right)\right\}$$

subject to :

$$\begin{aligned} c\left(z^t\right)+k\left(z^t\right)+\psi\left(k(z^{t-1}),k(z^t)\right) &= (1-\gamma)z_t k\left(z^{t-1}\right)^{\alpha}+(1-\delta)k\left(z^{t-1}\right) \\ c\left(z^t\right),k\left(z^t\right) &> 0 \end{aligned}$$

The parameter γ represent a permanent drop in output that countries experience upon default. It captures all the channels other than financial exclusion through which defaulting countries may suffer from their decision. The representative agent chooses contingent plans for consumption, capital and foreign asset to maximize (2.3.1) subject to (2.3.5), (2.3.6) and a no-Ponzi game condition :

$$b(z^t)\geq -D$$

where D is large enough that the constraint never binds in equilibrium.

The productivity shock follows an AR(1) process :

$$z_{t+1}=\rho z_t+\varepsilon_{t+1} \tag{2.3.7}$$

with ε_{t+1} is i.i.d. $N(0,\sigma_\varepsilon^2)$.

2.3.2 Competitive equilibrium

The model is solved for the stationary recursive competitive equilibrium. There are several allocations that satisfy the enforcement constraint (2.3.6). One such allocation is the autarkic allocation : no borrowing is possible and therefore there is no accumulation of foreign asset because the world economy is in equilibrium. The allocation satisfies the incentive compatible constraint because at any history node, the participation value is equal to the autarky value. As in Zhang [1997] and Alvarez and Jermann [2001] I consider the constrained efficient allocation featuring borrowing limits that are not too tight. In such allocation, the endogenous borrowing limits allow maximal risk sharing while preventing default in equilibrium.

If we denote by (b_0, k_0, z_0) the state variables, the problem of a country in the world economy admits the following recursive formulation :

$$V(b,k;z) = \max_{c,k',b'} \left\{ u(c) + \beta \sum_{z'} \pi(z'|z) V(b',k';z') \right\} \tag{2.3.8}$$

subject to :

$$\begin{aligned} c + k' + b' + \psi(k,k') &\leq zk^{\alpha} + (1-\delta)k + (1+r)b \\ b' &\geq \max\{-D,\ B(b,k,z)\} \\ c, k' &\geq 0 \end{aligned}$$

where $B(.)$ is the state contingent borrowing limit. Given the current state, it allows countries to borrow as much as possible while preventing them from defaulting in any possible state next period. Formally, it is defined as follows :

$$B(b,k,z) = \max_{z' : \pi(z'|z) > 0} \left\{ b_{z'} : V\left(b_{z'}, k', z'\right) = V^{aut}\left(k', z'\right) \right\} \tag{2.3.9}$$

where $k' \equiv k'(b,k,z)$ is the optimal capital stock for next period. Note that the endogenous borrowing depends on the current capital and asset holding only through the decision for next period's capital stock. Also, if the Markov chain is such that any state can be reached from anywhere in one period, then the endogenous borrowing limit can be expressed as a function of future capital stock only.

The autarky value $V^{aut}(k',z')$ in the equation (2.3.9) is solution to the following problem :

$$V^{aut}(k,z) = \max_{c,k'} \left\{ u(c) + \beta \sum_{z'} \pi(z'|z) V^{aut}(k'z') \right\}$$

subject to :

$$\begin{aligned} c + k' + \psi(k,k') &\leq zk^{\alpha} + (1-\delta)k \\ c, k' &> 0 \end{aligned}$$

In order to define the stationary equilibrium, some notations are in order. Let $\Omega = B \otimes K \otimes Z$ be the state-space and A_Ω the σ-Borel algebra of elements of Ω.

Definition. A stationary recursive competitive equilibrium of the world economy with endogenous borrowing limits is given by decision rules $c(b,k,z)$, $k'(b,k,z)$, $b'(b,k,z)$, solvency constraint $\bar{B}(b,k,z)$, world interest rate r and a distribution $\Psi : \Omega \longrightarrow [0,1]$ of countries over the state-space such that :

1. Given the initial condition, world interest rate r and solvency constraint $c(.)$, $k'(.)$, $b'(.)$ solve the problem of the world economy ;
2. The solvency constraints are not too tight in the sense of equation (2.3.9) ;
3. The world credit market is in equilibrium :

$$\int_\Omega b'(b,k,z) d\Psi(b,k,z) = 0$$

4. Decision rules and the transition matrix of the Markov chain π induce a probability distribution over the state-space : $P :\ \Omega \times A_\Omega \longrightarrow [0,1]$ where :

$$P\left((b,k,z),A\right) = \sum_{z':(b',k',z')\in A} \pi(z'|z)$$

1. The distribution Ψ is stationary and consistent with P, that is :

$$\Psi(A) = \int_Z P\left((b,k,z),A\right) d\Psi\left(b,k,z\right) \ \forall A \in A_\Omega$$

2.4 Calibration and computation

2.4.1 Calibration

I calibrate the model using parameter values that are standard in the literature. Preferences are isoelastic :

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma}$$

where $\sigma = 1.5$ is the coefficient of risk aversion. The discount rate is set to $\beta = 0.96$ and a capital share $\alpha = 0.33$ is assumed. Capital depreciates at a rate $\delta = 0.06$ each period. The parameter ϕ

of the adjustment cost function is calibrated to match the standard deviation of the log investment relative to that of the log output in the data for the period of 1970-1974. Table 2.II summarizes the parameter values.

Tableau 2.II – Parameter values

Description	Parameter
Discount factor	$\beta = 0.96$
Relative risk aversion	$\sigma = 1.50$
Capital share	$\alpha = 0.33$
Capital depreciation	$\delta = 0.06$
Level, adjustment cost	$\phi = 2.00$

The productivity process (2.3.7) is estimated from Solow residuals constructed using data from the Penn World Tables 6.3. I first construct the series of capital stock K_{it} using the perpetual inventory method. Following a standard practice [12], initial capital stocks are calculated by assuming that countries were in their non-stochastic steady-state until 1960. For each country i, it is obtained as :

$$K_{i1960} = \frac{IY_i}{\gamma_{in}\gamma_y - 1 + \delta} Y_{i1960}$$

where IY_i is the average of the real investment rates, γ_{in} and γ_y are the annual average of the growth rate of the labor force and the geometric world average of output per worker respectively, over the period of 1960-1970. Solow residuals $\hat{z}_{it}$ are then inferred as $\hat{z}_{it} = y_{it}k_{it}^{-\alpha}$, where y_{it} is the real GDP per worker from PWT 6.3, and k_{it} the series of capital stock per worker constructed from the data. Since we are interested in the insurable component of the productivity shocks, I estimate the parameters of the AR(1) process by running a fixed-effect panel regression on the residuals :

$$\ln \hat{z}_{it+1} = \mu + \rho \ln \hat{z}_{it} + u_i + \varepsilon_{it+1} \tag{2.4.1}$$

where $\varepsilon_{it+1}$is assumed to follow an identical and independently distributed normal distribution with mean zero and variance σ_ε^2. I obtain $\rho = 0.948$ and $\sigma_\varepsilon = 0.055$. The process is then discretized

12. See for instance Easterly and Levine [2001] and Castro [2005].

into a 5-states Markov chain using the method of Rouwenhorst [1995]. Table 2.III reports the set of values for the productivity shock together with the transition matrix Π.

Tableau 2.III – Discretization of the productivity shocks

z				
0.71	0.84	1	1.19	1.41
		Π		
0.900	0.096	0.004	7E-05	5E-07
0.024	0.902	0.072	0.002	2E-05
0.001	0.048	0.903	0.048	0.001
2E-05	0.002	0.072	0.902	0.024
5E-07	7E-05	0.004	0.096	0.900

2.4.2 Numerical solution

The computational procedure builds on Bai and Zhang [2010]. They showed that the solution to the problem can be obtained by solving a sequence of recursive problems where the enforcement constraint is replaced by a debt limit function. Starting from the natural borrowing limit, the model is solved and the borrowing limit is updated iteratively until convergence. The algorithm has three loops of iterations. The outer loop solves for the interest rate that clears the world bond market. Taking the world interest rate as given, the second loop starts with a guess for the borrowing limit. The associated recursive problem is solved and the borrowing limit is updated. This is repeated until the borrowing limit converges. Finally, for a given interest rate and debt limit, the outer loop solves for decision rules that solve the system of first-order conditions for the country's problem. A detailed description of the algorithm is provided in appendix II.2.

2.5 Findings

In the quantitative analysis, I calibrate the output cost of default to match the evolution of the standard deviation of net foreign asset positions over 1970-2004. I then examine the implications for the distribution of investment rates. This section is divided in three parts. I first discuss the calibration of the output loss parameter. In the second part, I present the implications of the model

for the dispersion in investment rates. The third part presents some features of the endogenous borrowing limit.

2.5.1 Matching the evolution of the dispersion of NFA positions

I consider two scenarios. In the benchmark model, the output cost of default γ is calibrated to match the standard deviation of net foreign asset positions observed in the data for the period of 1970-1974, that is 0.17 (see table 2.I). This model will be referred to as the "less integrated period". In the alternative scenario, γ is calibrated to generate a standard deviation of 0.39 for the net foreign asset positions, consistent with the one observed in the data for the period 2000-2004 : this is the "more integrated period". Note that I am comparing steady-states and the analysis is silent about the transitional dynamics between those steady-states.

The standard deviation in the model are computed to be comparable with their counterpart in the data. From the stationary distribution of world economy, I draw $\{i = 1, \ldots, 150\}$ countries characterized by their initial conditions (b_{i0}, k_{i0}, z_{i0}). For each initial condition, I follow the country for five periods to obtain a panel for the external asset position to output ratio. [13] The top and bottom deciles are dropped and the standard deviation is calculated from the remaining sample of 120 countries. The procedure is repeated 1,000 and I take the average of the standard deviations.

Tableau 2.IV – Equilibrium statistics

	Less integrated	More integrated
Output cost γ	1.1%	2%
World interest rate	3.26%	3.43%
Incidence borrowing constraint	48%	28%

Table 2.IV reports some steady-state statistics under both scenarios. It shows that a penalty cost of 1.1 percent drop in output is required for the model to match the NFA dispersion for the period of 1970-1974. This cost can be considered as large compared to models of sovereign borrowing where international lending contracts are enforced by reputation only. Such models are equivalent to assuming a default penalty cost to zero percentage drop in output. This high value suggests that even during the 1970s, the dispersion in international capital flows is not comparable to a world of

13. For each country, the net foreign asset position is calculated as in the data, as follows : $\left[\frac{NFA}{GDP}\right]_i = \sum_{t=1}^{5} \frac{b_{it}}{z_{it} k_{it-1}^{\alpha}}$

closed economies.

In the alternative calibration corresponding to the more integrated period, matching the dispersion of NFA positions for the recent period of 2000-2004 requires a penalty of 2% of output drop. Interestingly, the parameter values found in the calibration are within the ranges of empirical estimates. For instance, using growth regressions, Sturzenegger [2004] estimated that default is associated with an output drop between 1.9 and 2.1 percent for the first year of default. Similarly, comparing actual GDP with Hodrick-Prescott filtered trend, Tomz and Wright [2007] found that output was below trend by about 1.6 percent in the first year of default, and on average by 1.4 percent during defaulting periods.

The table also shows that the interest rate that clears the international asset market is lower in the less integrated model than in the more integrated one. As countries are able to hold larger amounts of debt, world interest rate has to go up in order to clear bond markets. Finally, 48 percent of countries are borrowing-constrained in the calibration corresponding to the less integrated period compared to 28 percent for the more integrated period.

Figure 2.2 – Cross-sectional dispersion of NFA/GDP ratios in the model

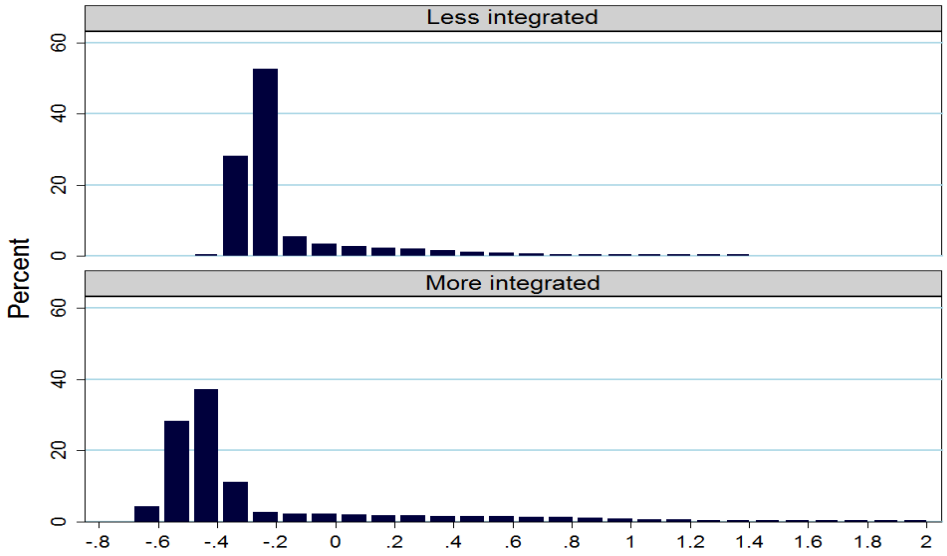


Figure 2.2 compares the distribution of NFA positions under the two calibrations. It is the model counterpart of 2.2(a). As in the data, I drop the top and bottom deciles and restrict the sample to the

80 percent range. The histograms are based on a combination of 1,000 samples of 120 countries each. Compared to the less integrated period, there is a shift of the distribution toward the tails when we look at the figure corresponding to the more integrated period. Consistent with fact 3, the mean of the distribution has also gone down. For $\gamma = 1.1\%$, a majority of countries have negative net foreign asset positions comprised between 20 and 40 percent of their output. When the cost increases to 2%, the mass shifts to the range of 40 to 60 percent of output.

Similar to the data, there is a larger mass of the distribution on the negative side than on the positive side reflecting the fact that the stationary distribution is characterized by a large number of countries with small external liabilities and a few countries with large external assets. This is different from CKL who found a distribution of NFA positions that is symmetric around zero (see figure 5 in their paper). Such distribution is not consistent with the data on net foreign asset positions. And as discussed in section 2.2, the distribution needs not to be symmetric even in absence of the under-reporting of the statistics on net foreign assets.

This distribution is largely due to the endogenous borrowing limit. Because it is state-dependent, countries with different capital stock levels face different debt levels, generating the dispersion. This contrast with models with exogenously given borrowing limit where the borrowing limit is either set to a constant (as in CKL) or a constant fraction of wealth (as in Castro [2005]. In such models, there is a larger accumulation on the borrowing side. Note however, there we have more accumulation on the borrowing side than in the data. In the model, there is only a small fraction of countries with positive net foreign asset positions while in the data, the proportion is larger. One reason may be the fact that there is not enough dispersion in the endogenous borrowing limit faced by countries. Still, the results suggests that the heterogeneity in the ability of countries to raise external capital matters for the dispersion.

Similar to CKL, results here show that a change in the sovereign borrowing environment can account for the evolution of the global dispersion in net foreign asset positions. Changes in the output cost of default within the range of empirical estimates are sufficient to reproduce the rising dispersion in net foreign asset positions. In fact, the output cost to default has two effects. By making default more costly, it allows countries to hold large debt levels in equilibrium, thereby increasing the dispersion on the left tail. This reduces precautionary savings as countries are less likely to be credit-constrained. But the world interest rate has to adjust upwards for the bond market

to be in equilibrium. This renders foreign asset more attractive for countries running surpluses, inducing them to build even larger external assets. The adjustment costs tempers the response of investment to productivity shocks and therefore, capital flows. The building of foreign assets and liabilities takes place only gradually, generating less volatile external imbalances.

2.5.2 The distribution of investment rates

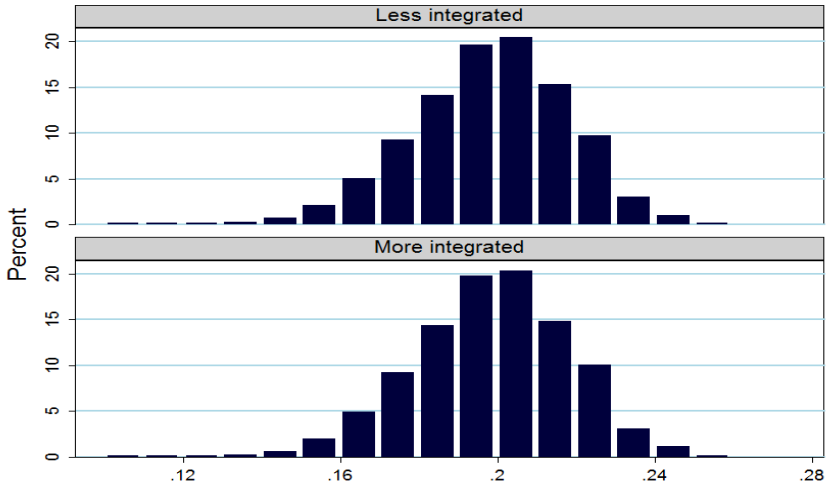
The implications of the model for the dispersion in investment rates are summarized in table 2.V. Moments are calculated using the same sample as the one used for net foreign asset positions and the statistics are based on averages over 1,000 simulations. All the three measures of dispersion reported in the table point to a slight decline in the dispersion of investment rates.

Tableau 2.V – Moments of the distribution of investment rates in the model

	Model	
	$\gamma = 1.1\%$	$\gamma = 2\%$
Mean	0.198	0.199
Median	0.199	0.201
Min	0.143	0.147
Max	0.242	0.243
Std. dev.	0.100	0.093
Coeff. of variation	0.098	0.090
Gini coefficient	0.055	0.051

This result is in part due to the presence of adjustment cost to capital. But there are also other factors that govern the distribution of investment rates in the model. The distribution of investment rates depends on the incentives to invest and the access to resources to do so. These are determined by the productivity shocks and the borrowing limit. Since I am looking at stochastic steady states, there is no scope for convergence and the dispersion has to come from transitional dynamics or a relaxation of the borrowing constraint. However, the borrowing limits only affect countries that are constrained while the productivity shocks affect everyone. Therefore, even though the world economy has become more integrated, the incentives to invest have not changed much, resulting in a relatively stable dispersion in investment rates.

Figure 2.3 – Cross-sectional dispersion of investment rates in the model



To see this, I solve the model using the same values for the output cost of default but by setting the capital adjustment cost to zero. Results reported in table 2.V.I show that the dispersion of investment rates increases slightly when we move from $\gamma = 1.1\%$ to $\gamma = 2\%$: the standard deviation increased from 0.24 to 0.276 (an increase by 16 percent). This increase is however still small compared to that of the net foreign asset positions. The standard deviation of NFA positions increase nearly by 40 percent, from 0.227 to 0.316.

Tableau 2.VI – Model with no adjustment cost

	Investment rates		NFA positions	
	$\gamma = 1.1\%$	$\gamma = 2\%$	$\gamma = 1.1\%$	$\gamma = 2\%$
Mean	0.197	0.204	-0.164	-0.281
Median	0.207	0.208	-0.268	-0.428
Min	-0.033	-0.051	-0.374	-0.609
Max	0.377	0.534	0.594	0.677
Standard deviation	0.240	0.276	0.227	0.316
Coeff. of variation	0.352	0.401	-1.509	-1.129

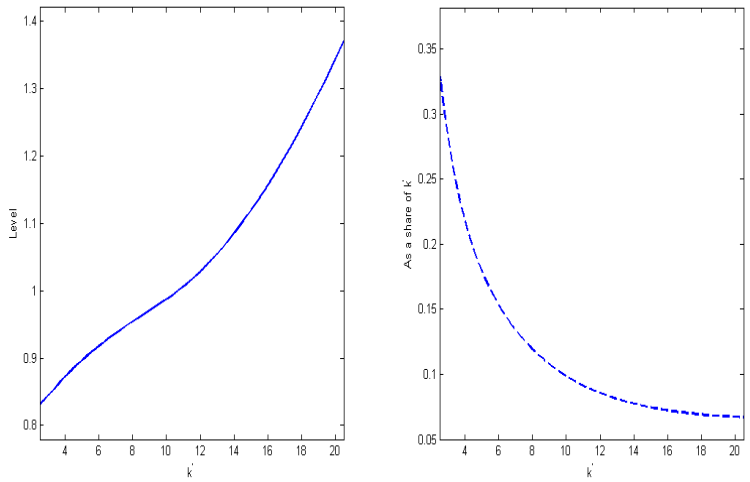
2.5.3 The endogenous borrowing limit

As defined in equation (2.3.9), the borrowing limit depends on current state variables b, k and z. However, it can be expressed as function of next period's capital stock k' only. In fact, it depends on

current asset position and capital stock to the extent that they determine next period's capital stock k' because k' is also the capital stock under the outside option of financial autarky. Thus, (b,k) can be summarized by k'. It depends on the current realization of shock z because z determines the set of states that can be reached next period. However, this does not apply here because all entries of the transition matrix of the Markov chain are positive as we can see from table 2.III. This means that from any state, it is possible to reach any other state in one period although with different probabilities.

Figure 2.4 plots the debt limit as function of next period's capital stock k'. The first panel of the figure plots the level of debt limit and shows that the borrowing limit is increasing with next period's capital stock. In absolute terms, countries that invest more tend to be rewarded with a relatively more generous borrowing limit. This result supports the view that it is easier to borrow to finance investment than consumption. It is consistent with models featuring collateral requirements : in order to borrow, countries have to put up some collateral. This reward however declines with investment as suggested by the second panel of the figure. The panel plots the debt limit as a share of next period's capital stock. It shows that such share is declining with the level of next period's capital stock.

Figure 2.4 – Endogenous debt limit as function of next period's capital stock k'



In fact, there are three mechanisms that determine the size of the borrowing limit. The first two

mechanisms are related to the decision for investment. Note that the debt limit is determined by the wedge between welfare under the two options : financial participation and financial autarky, both of which are increasing with future capital stock. Consequently, the overall effect of investment decision on borrowing limit is ambiguous. Holding everything constant, if the marginal utility derived from an additional unit of capital under autarky is higher than the marginal utility under financial participation, the debt limit will be decreasing in future capital stock. The figure suggests that it is the reverse that is true.

There is a third mechanism coming from the capital adjustment cost. The risk-free asset is also used as a buffer stock and allows countries to avoid, to the extent possible, costly adjustment to capital stocks. Investment does not adjust instantaneously in response to a productivity shock as it is the case in the absence of capital adjustment cost. Even countries with high levels of capital stock may prefer to smooth consumption through the international bond rather than making large adjustments to investment levels. Consider a rich country experiencing a bad productivity shock. Without access to external borrowing, the country will have to cut down on domestic capital in order to maintain the desired level of consumption. However, such change is costly and the larger the size of the adjustment, the larger the cost. With access to external borrowing, the country can afford the same level of consumption without incurring the cost of capital adjustment, by borrowing on the external financial markets to finance consumption and reducing the capital stock only gradually.

2.6 Conclusion

In this paper, I undertake a quantitative analysis of the dynamics of net foreign asset positions and investment rates. The model features productivity disturbances and financial frictions. International borrowing and lending are sustained by the threat of financial exclusion as well as an exogenous drop in output upon default. This drop captures all the other channels beyond autarky that make default costly. The debt limit is not exogenous : there is a mapping between the output cost of default and the debt limit arising endogenously in equilibrium. The output cost parameter is calibrated to match the evolution of the cross-sectional dispersion of net foreign asset positions. First, I obtain parameter values are within the range of empirical studies. Second, consistent with

the data the model predicts a relatively stable dispersion of investment rates. It supports the view that with the rapid integration of world economies, countries have become inter-dependent along several dimensions, raising the cost of living in financial autarky. As a consequence, large debt levels can be sustained in equilibrium.

On the negative side, the model generates too little dispersion in investment rates. One way to improve the model on this front is to consider barriers to investment as in Restuccia and Urrutia [2001] or investment specific shocks as in Castro [2005]. Another limitation is that I do not model explicitly the determinants of the key parameter, the output cost of default. One area for future research is to model a specific channel through which default can spillover to other relationships. These are left for future research.

CHAPITRE 3

AN EMPIRICAL ANALYSIS OF THE PROLIFERATION OF PREFERENTIAL TRADE AGREEMENTS

3.1 Introduction

The proliferation of Preferential Trade Agreements (PTAs) is one of the major phenomena in the multilateral trading system over the recent decades. According to the World Trade Organization (WTO), the cumulative number of such agreements notified to the GATT/WTO has increased from below 20 in 1992 to more than 450 by the end of 2009. [1] About 250 of these agreements were active as of 2009. Surprisingly, this recourse to regionalism is taking place at a time when world trade flows have reached unprecedent levels, prompting some interrogations about whether they are stumbling blocks or stepping stones to a world of globally free trade (see for instance Frankel and Wei [1996], Limão [2006] or Bhagwati [2008]). [2]

The empirical analysis usually focuses on their long-term determinants. Baier and Bergstrand [2004] found that the potential welfare gains and the probability of PTA formation between two countries are higher for countries that are closer in distance, remote from the rest of the world, larger and more similar economically, and predisposed to gain from their comparative advantage. [3] These findings support the natural trading partner hypothesis according to which preferential trade agreements are formed along the lines of countries that are naturally predisposed to trade largely with each other (see Wonnacott and Lutz [1989], Krugman [1991] and Frankel, Stein, and Wei [1995]). In this view, the decline in transportation cost observed over the last decades is consistent with the proliferation of preferential trade agreements.

The domino theory, an alternative explanation proposed by Baldwin [1993, 1995, 1999] suggests that the trade discrimination faced by excluded countries following the creation of a PTA or the deepening of an existing one can induce them to join or form new agreements. Egger and Larch [2008] (hereafter EL) attempted to address this view by investigating the role of interdependence in

1. From the WTO website http ://www.wto.org/english/tratop_e/region_e/region_e.htm accessed on July 20, 2010.
2. See also Frankel [1997, chap. 10] or World Bank [2000, chap. 5].
3. Magee [2003] found similar results and also that countries are more likely to be preferential trading partners if they have significant bilateral trade.

PTA formation and enlargement. Interdependence is captured by a measure of geographical proximity of the country-pair contemplating forming a PTA to existing preferential trade areas. Their results suggest that preferential trade agreements that are geographically close are more likely to induce excluded countries to join or seek similar arrangements.

This paper extends their approach to explore a specific channel of interdependence in PTA formation : the diversion of imports away from a non-member partner to a PTA partner. This typically occurs if the duty-free imports from the member partner turn out to be cheaper than imports from the non-member. [4] The granting of trade preferences creates an asymmetry between firms inside the PTA and firms from the excluded countries, resulting in a loss of exports of the latter. And the more the excluded country exports products that PTA members can import from each other, the higher the risk trade discrimination.

I adapt the trade complementarity index developed by Michaely [1962] to derive a measure of the exposure to such discrimination : the potential of trade diversion. In this context, the index captures to what extent products exported by a country-pair match products that PTA members import from each other. The closer the match, the higher the potential of trade diversion. Using this measure for PTAs that are geographically proximate to the country-pair, I estimate a probit model using five-year interval panel data sets of 161 countries covering the period 1961-2005. The results support the view that country-pairs that are more likely to suffer from trade diversion have a significantly higher probability of forming a PTA. The effect is robust to controlling for EL's measure of interdependence, which is based on geographical proximity with existing PTAs. Also consistent with existing studies, results show that natural trading partners are more likely to form a PTA.

This paper relates to the literature investigating the determinants of PTA formation. Most of the analysis on the "domino theory" are in the context of European countries. In one the introductory papers to the domino theory, Baldwin [1995] discussed some evidence on the domino effect in PTA formation. He argued that the European Community's Single Market Programme constitutes a special threat to countries from the European Free Trade Association (EFTA) because a majority

4. Such diversion is harmful for the importing country if the pre-tax imports from the excluded country is cheaper than the pre-tax imports from the PTA partner : it is as if the importing country is subsidizing imports from its PTA partner. This effect is coined by Viner [1950] as trade diversion. This side of trade diversion is one of the effects of trade preferences that is covered extensively in the literature. It is so because it is a loss for the world trading system as well since trade is displaced from an efficient supplier to a non efficient supplier.

of their exports went to the EC market. This threat may have triggered a "domino effect" leading successively Austria, Sweden, Finland, Norway and Switzerland to seek membership. This was confirmed empirically by Sapir [2001] who was one of the first attempts to take the domino theory to the data.

Baldwin and Rieder [2007] explored empirically the role of trade diversion in the demand of membership for European Union (EU) accession. They captured the domino effect using two variables. The first variable reflects the importance of the EU bloc as a trading partner to the country and is the share of the country's exports that go to EU countries. The second variable captures the deepening of the EU and is a measure of the degree of participation of countries to EU institutions. They found that both variables have a positive impact on the likelihood of joining the EU. Baldwin and Jaimovich [2010] explored the "contagion" effect in PTA formation, that is the extent to which countries tend to seek PTAs with partners that already have PTAs with their major trading partners. Borrowing from the literature on financial crisis contagion, they used a contagion index that is, for a given country-pair, the share of exports of the reference country that goes to third countries with whom the partner country has a trade deal. They found the contagion effect to be important in PTA formation. The main departure from these papers is that the measure of interdependence variable is not based on aggregate bilateral trade flows. I exploit the availability of product-level data to measure to what extent excluded countries are exporting products that can be prone to trade diversion.

The paper is organized as follows. The next section reviews the literature on the economic effects of PTAs and describes the hypothesis tested in the paper. Section 3 lays out the empirical model, discusses the variables used and the data set. Section 4 presents the results and section 5 concludes.

3.2 Evidence on trade diversion and hypothesis of the study

3.2.1 Trade effects of preferential trade agreements

Since the pioneering work of Viner [1950], the analysis of the economic effects of preferential trade agreements is usually framed in terms of trade creation and trade diversion. There is trade creation when, as a result of trade preferences, imports from a member country replace goods that

used to be produced domestically. This leads to an increased efficiency within the preferential trade area as the partner country proves to be a lower-cost producer compared to domestic producers. Although domestic producers will suffer a temporary loss because of competition from the PTA partner, the resources freed can be used more efficiently in another sector where the home country has a relative comparative advantage. In short, trade creation is welfare improving and therefore desirable.

Trade is diverted when imports are shifted away from an efficient non-member supplier to a less efficient member supplier. This typically happens if the duty-free imports from the member country is cheaper than the imports from the non-member partner. Although the domestic consumer is paying less for the same goods, the surplus does not necessarily compensate for the loss in tariff revenue and the importing country ends up being worse off. But the excluded country is also affected as domestic firms are not competing on equal ground with firms in the preferential trade area.[5] In such case, if it is not possible to join an existing PTA, affected countries may choose to engage in a PTA with other outsiders to mitigate these effects.

The logic of the vinerian approach is illustrated in this example from Krugman [1991]. Consider the following scenario of trade in wheat between Spain, France and Canada. Imagine that Spain can produce wheat for itself or import it either from France or Canada. Assume that the cost of a domestically produced bushel of wheat is 10 while a bushel of wheat bought from France and Canada cost respectively 8 and 5 as reported in table 3.I. Assume also that initially there is no trade preferences and imports from France and Canada are subject to the same duties. Depending on the level of duties, Spain will either grow domestically its own wheat or import it from Canada. If the tariff on imports is 4, Spain will import its wheat from Canada, the low-cost supplier.

Suppose that Spain signs a free trade agreement with France and imports from France are duty-free. If the pre-RTA tariff on imports was for instance 6, Spain will replace the wheat that it used to produce with wheat imported from France, leading to trade creation. Now, if the initial tariff was 4, Spain will shift away its imports from Canada to France even though Canada is the lower-cost producer, leading to trade diversion. This diversion occurs because wheat imported from Canada,

5. This is also a cost for the world trading system as this trade is not along the lines of the comparative advantage.

Tableau 3.I – Illustration of trade volumes effects of trade preferences

	No FTA			FTA with France		
	Home	France	Canada	Home	France	Canada
Production cost	10	8	5	10	8	5
Imports duty	0	4	4	0	0	4
Price paid by :						
consumer	10	12	9	10	8	9
society	10	8	**5**	10	**8**	5

which is subject to duties costs 9 while wheat imported from France costs only 8. At the end, no additional trade is created. It is only diverted away from Canada to France, thereby hurting Canada's exports in a sector where it has a comparative advantage relative to France. Note that Spain, the importing country is also adversely affected by trade diversion : although consumers enjoy lower prices for imports, this surplus is gained at the expense of a higher loss in tariff revenue. Overall, it is as if Spain is subsidizing imports from France.

In the literature, trade diversion is generally analyzed from the perspective of the PTA member : the question of the desirability of a PTA boils down to a trade-off between its trade creating effect (which is welfare increasing) and its trade diverting effect (which is welfare reducing). [6] In this paper, I take the view of the excluded country and define trade diversion to include broadly a loss of exports due to the presence of a PTA. From the perspective of such country, it matters very little whether the displacement of its exports is going to a more efficient producer or not. This can induce the country either to reduce the price on its exports or to reallocate the resources used to produced the exported goods to another sector. All those adjustments are costly and this cost may feed pro-RTA pressures in order to mitigate those costs.

Although the emphasis here is on trade volume effects, trade preferences can also affect excluded countries through their terms-of-trade [Mundell, 1964]. If a country abolishes duties on imports from a partner, the terms of trade of the partner improve because its exports become cheaper. Also, as imports are shifted away from third-countries to the PTA partner, firms in the third-countries have to reduce their price in order to remain competitive, leading to a deterioration of the terms-of-trade of the country. Winters and Chang [2000] examined the effect of Spain's accession to the

6. See Frankel, Stein, and Wei [1995] for an analysis of this trade-off in connection with the transportation costs. See also Magee [2008] for a measure of trade creation and trade diversion.

European Community on the price of some non-member's exports to Spain. They found that the price of US exports of finished manufactures has declined. Gupta and Schiff [1997] documented how the Andean Pact had displaced Peru's imports of beef and cattle from the excluded Argentina to Colombia, a partner exporting the same products. This has caused producers from Argentina to lower their prices in order to access the market.

It is also important to note that there are circumstances under which PTAs can increase trade from non-members. For example, a PTA can raise demand for certain imports from the rest of the world due to complementarity, raising imports from non-members. Also, PTAs can involve further opening of markets to international competition, regulations and policies. The increased efficiency within the preferential trade area can lead to higher income and therefore, larger demand from the rest of the world. I assume that such effects are small compared to the negative externalities and therefore abstract from them.

3.2.2 Hypotheses

The hypotheses of the study are the following :

Hypothesis 1 : Countries that face a higher potential of trade diversion due to the presence of PTAs exhibit a higher probability of forming a PTA.

The potential of trade diversion is captured by a variable measuring to what extent products exported by a country-pair are also traded within the preferential trade area. If firms from a country-pair are exporting products that are traded heavily by PTA partners, they are more likely to suffer from trade diversion because they are competing against domestic firms enjoying trade preferences.

By focusing on trade diversion, I am investigating a specific aspect of the domino theory. The theory as presented by Baldwin [1993] however does not refer only to trade diversion. It refers to all political-economy forces that can emerge in the excluded country as a result of the formation of a preferential trade area or its deepening. A preferential trade area represents a big market in itself and even in absence of trade diversion, firms from excluded countries may increase lobbying pressure in order to have access to the market. In addition, an increased efficiency within the preferential trade area can raise demand from the rest of the world, but also its attractiveness, and hence the incentives for excluded countries to seek similar deals.

Hypothesis 2 : PTAs are more likely to be formed among natural trading partners.

This hypothesis emphasizes trade gains as a major determinant of preferential trade deals. Natural trading partners are countries that were already trading a lot prior to the formation of the PTA. This can be due to geographical proximity which is usually associated with low trade cost, complementarity or relative levels of economic development. For such partners, the gains from trade creation are likely to outweigh the loss from trade diversion as suggested by Krugman [1991]. A common proxy of whether countries are natural partners is their bilateral distance. This relies on the fact that trade costs usually increase with bilateral distance and therefore, geographically close countries can be considered as having relatively low trade costs.

3.3 Empirical analysis

The model of PTA formation is a qualitative choice model. Following EL, interdependence is captured by an additional explanatory variable that is function of "ties" with existing PTAs. The main departure from their paper is the measure of those ties. Below, I describe in more detail the approach.

3.3.1 The econometric specification

Let $N = n \times n$ be the number of country-pairs and $\text{PTA}_t^\star$ a $N \times 1$ vector of differential in utility between membership and non-membership of a PTA. $\text{PTA}_t^\star$ is unobservable. Instead we observe PTA_t, which is a vector of dummies whose entries take the value of 1 for country-pairs that are in a PTA in year t, including new PTAs (that is $\text{PTA}_{ij}^\star > 0$) and 0 otherwise. I assume that the differences in utility from forming a PTA are function of current and past economic conditions. However, whether a country-pair forms a PTA or not depends on the value of such difference in utility in the previous period. This reflects the fact that the formation of a PTA is typically a long process and agreements entering currently into force are the outcomes of decision taken many years ago, and therefore triggered by conditions prevailing at that time.

The model of PTA formation is :

$$\text{PTA}_{t-5}^\star = \rho W_{t-5}\text{PTA}_{t-5} + X_{t-5}\beta + \varepsilon_t \tag{3.3.1}$$

$$\text{newPTA}_t = \mathbf{1}\left[\text{PTA}_{t-5}^\star > 0\right] \tag{3.3.2}$$

where

- W_t is a $N \times N$ matrix whose entry κ, τ captures the potential of trade diversion faced by exports from country-pair $\kappa = (\kappa_1, \kappa_2)$ in the country-pair $\tau = (\tau_1, \tau_2)$;
- X_{t-5} is a $N \times k$ matrix of k regressors ;
- β is a $k \times 1$ vectors of parameters ;
- ε_t is a $N \times 1$ vector of residual terms ;
- newPTA$_t$ the $N \times 1$ vector such that newPTA$_{\kappa t} = 1$ if the pair κ forms a new PTA in period t and 0 if κ was not a PTA in $t-5$ and t. Continuing PTAs are excluded from the estimation and the corresponding entry is set to a missing value. [7]
- $\mathbf{1}[.]$ is the indicator function.

The effect of past PTAs on the current ones is captured by W_{t-5}PTA$_{t-5}$, a variable placing weight on country-pairs that are in a PTA in period $t-5$. The measure gives more weight to existing PTA at time $t-5$ which are more likely to divert trade with the outsider country-pair. The conjecture is that this trade diversion would encourage the outsider to form a PTA 5 years later.

A few remarks are in order. First, in each period we are interested in the effect of pre-existing PTAs on the new ones and the dependent variable is therefore restricted to country-pairs that were not in a PTA in the previous period, that is PTA$_{it-5} = 0$. This is a restriction compared to EL who estimated separate models for continuing PTAs, new PTAs and PTA enlargement. The restriction however is without a loss of generality since their results did not change much across the three specifications. A consequence of this choice is that the number of observations for the dependent variable is declining with time as continuing PTAs are dropped. [8]

Second, I abstract from short-term fluctuations in some of the independent variables by aggregating the panel into 9 periods of five-year intervals covering the period 1961-2005. This has the advantage of increasing the variability in the dependent variable : any agreement created during one of the five years is considered as a PTA formation while the non-existence of such agreement for all the five years is combined into one single observation of no agreement. Each period covers the years $\{t-2, \ldots, t+2\}$ with t taking values in $\{1963, 1968, 1973, 1978, 1983, 1988, 1993, 1998, 2003\}$.

7. This trick is used only to keep the vectorial notation consistent. One way to avoid this is to make the dimension of the matrices time-dependent.

8. I assume that those are the only countries that can create a PTA in period t and by doing so, ignore the death of PTAs. In practice, such events are rare in the sample.

With a little abuse of notation, I use the subscript t to denote the 5-year period, and $t-5$ and $t+5$ to denote respectively the previous and the next period.

The model defined by equations (3.3.1) and (3.3.2) belongs to the class of models with a spatially lagged dependent variable. A frequent issue with these models is that the spatial lag is usually endogenous and correlated to the error terms, leading to a bias in the coefficient estimates when the endogeneity is not properly taken into account. This specification is however purely a space recursive model as PTA_{t-5} is pre-determined at time t and there is no serial correlation in the residuals [Ward and Gleditsch, 2008].

3.3.2 Construction of the weighting matrix W

The weighting matrix W is derived from TD, a matrix whose entries measure the potential of trade diversion between country-pairs, and D a matrix of distances.

3.3.2.1 The potential of trade diversion TD

TD is a $N \times N$ matrix measuring the potential of trade diversion faced by exports from a country-pair κ in the market of another country-pair τ. To measure this potential, I adapt the trade complementarity index developed by Michaely [1962]. The trade complementarity index was developed originally for comparing trade profiles at country levels : it shows how well the exports structure (supply) of a country matches the imports profile (demand) of a partner. As such, it provides a useful information on the prospects for bilateral trade.

I extend this logic at country-pair level to measure to what extent exports from a country-pair are likely to suffer from trade diversion in another country-pair. The idea is the following : if countries $\{\kappa_i\}_{i=1,2}$ are exporting to the world products that are similar to the ones countries $\{\tau_i\}_{i=1,2}$ are importing from each other, the prospect of a trade deal between $\{\tau_i\}$ is potentially harmful to exporters from $\{\kappa_i\}$. The granting of mutual tariff preferences renders bilateral imports between τ_1 and τ_2 cheaper, creating an asymmetry between firms in κ and firms in τ : consumers within the preferential trade area are likely to divert their demand away from κ_1, κ_2 to their PTA partner. This asymmetry can nourish politico-forces for the creation of a PTA in κ_1, κ_2.

Formally, let $x^k_{\kappa t}$ be the share of product k in the aggregate exports of $\{\kappa_i\}_{i=1,2}$ to the world and $m^k_{\tau t}$ the share of the same commodity in the imports of $\{\tau_i\}_{i=1,2}$ from each other. The potential of

trade diversion faced by exports from κ in the market of τ is defined as :

$$\text{TD}_{\kappa\tau t} = 1 - \frac{1}{2}\sum_{k}\left|x^{k}_{\kappa t} - m^{k}_{\tau t}\right| \tag{3.3.3}$$

The index ranges from 0 to 1, with 1 reflecting perfect complementarity between exports of κ and bilateral imports of τ, and therefore a higher potentiality of trade diversion. The extreme case where the index is zero reflects a situation in which none of the product exported by κ_1, κ_2 are traded between τ_1 and τ_2. In such case, there is no scope for trade diversion since firms from κ do not have any competitor in τ. Note that the index is not symmetric : the potential of trade diversion faced by exports from κ in the market τ is not the same as the potential of diversion faced by exports of τ in κ.

3.3.2.2 Distance D :

The distance between two country-pairs κ and τ is defined as the average distance between all the combinations of two countries from one pair and the other :

$$D_{\kappa\tau} = \frac{1}{4}\sum_{i=1}^{2}\sum_{j=1}^{2}\text{DIST}_{\kappa_i\tau_j} \tag{3.3.4}$$

where $\text{DIST}_{\kappa_i\tau_j}$ is the bilateral distance between countries κ_i and τ_j measured in kilometers (kms).

I use D here to restrict some entries of the weighting matrix W to zero because its construction is computationally intense. For instance, with 161 countries, W is a $25,921 \times 25,921$ matrix and the memory requirement becomes quickly an issue. [9]

3.3.2.3 The weighting matrix W

Given TD_t and D, the weighting matrix W_t is defined by :

$$W_t = \text{TD}_t \times \mathbf{1}[D < 2000 \text{ kms}] \tag{3.3.5}$$

I restrict $W_{\kappa\tau t}$ to be zero for country-pairs that are more than 2,000 kms apart. [10] Rows of W_t are

9. The interdependence variable $W_t\text{PTA}_t$ is computed in Lahey/Fujitsu Fortran 95.
10. This threshold is also used in Bergstrand, Egger, and Larch's (2010) analysis of the timing of PTAs.

normalized to sum to unity. The main departure from EL is the definition of the non-zero entries of the weighting matrix. In their paper, it is based on the inverse distance ($e^{-D_{\kappa\tau}/500}$) while here, it is based on the potential for trade diversion.

3.3.3 Other Variables

The dependent variable newPTA$_{ijt}$ is a binary indicator that takes the value of 1 if there is a preferential trade agreement between countries i and j entering in force in period t, and 0 if there is no PTA. As discussed previously, the country-pair ij is then dropped from the dependent variable sample and the corresponding entry in the vector newPTA is set to a missing value. As a consequence of this assumption, all the country-pairs that were in a PTA before 1961, the beginning of the period of study were dropped from the analysis. [11]

The explanatory variables are :

– NATURAL (-) is the logarithm of the bilateral distance and captures the natural trading partner hypothesis :

$$\text{NATURAL}_{ij} = \log \text{DIST}_{ij}$$

Thee idea is that countries that are closer geographically tend to have lower trade costs and therefore can consume more of each other's varieties. Hence, they have a natural predisposition to trade largely with each other. A trade deal between such countries raises welfare because it is likely to be more trade creating than trade diverting [Krugman, 1991].

– RGDPsum (+) is the sum of real GDP and captures the market size of the country-pair :

$$\text{RGDPsum}_{ijt} = \log\left(RGDP_{it} + RGDP_{jt}\right)$$

where $RGDP_{it}$ and $RGDP_{it}$ are real GDP for i and j in year t. It is expected to affect positively the probability of PTA formation : the larger the market size, the bigger is the scope for trade gains because there are more varieties available for consumption and welfare is increasing with varieties. In addition, there is room for greater competition and specialization.

11. They were re-included in the dependent variable only if the agreement has broken down.

– RGDPsim (+) measures the similarity between two countries in terms of the economic size :

$$\text{RGDPsim}_{ijt} = \log\left[1 - \left(\frac{RGDP_{it}}{RGDP_{it} + RGDP_{jt}}\right)^2 - \left(\frac{RGDP_{jt}}{RGDP_{it} + RGDP_{jt}}\right)^2\right]$$

The measure ranges from 0 to 1. An index close to 0 reflects an asymmetric country-pair : one of the countries accounts for almost all of the pair's GDP. On the other hand, a value close to zero is indicative that the two countries are of similar size.

– DKL (+/-) is the absolute of the difference in real GDP per capita :

$$\text{DKL}_{ijt} = \log\left|\frac{RGDP_{it}}{POP_{it}} - \frac{RGDP_{jt}}{POP_{jt}}\right|$$

There are opposite views on the relationship between income differences and the likelihood of PTA formation. Krueger [1999] argued that a preferential trade agreement between a developed and a developing country is more likely to improve welfare than one between two similar countries because similar countries have less scope for trade gains based on comparative advantage.

However, from a political economy perspective, preferential trade agreements are more difficult between countries with large differences in income per capita because of possible political opposition in the rich partner. [12] An evidence supporting this argument is the formation of the Canada-US free trade area (CUSTA) and the extension to Mexico (NAFTA). The negotiation of the free trade area between US and Mexico (which will lead to the creation of the NAFTA) faced more opposition from the US House and Senate that the formation of the CUSTA itself (see Beaulieu [2002]).

I also include the square of DKL to capture any nonlinearity in the relationship with income per capita.

– REMOTE(+) measures to what extent a pair of continental trading partners are far from other countries :

$$\text{REMOTE}_{ij} = \text{Continent}_{ij}\frac{1}{2}\left\{\log\left(\sum_{k\neq j}\frac{\text{DIST}_{ik}}{n-1}\right) + \log\left(\sum_{k\neq i}\frac{\text{DIST}_{jk}}{n-1}\right)\right\}$$

12. See Levy [1997] for a discussion of some political economy arguments.

where $\text{Continent}_{ij} = 1$ if i and j are on the same continent and n, the number of countries. Welfare of two continental trading partners increases with their remoteness from the rest of the world. The variable takes the value of zero for countries located on different continents.

– DROWKL(+) is a measure of the relative factor endowment between a country-pair and the rest of the world :

$$\text{DROWL}_{ijt} = \frac{1}{2}\left\{\left|\frac{\sum_{k\neq i} RGDP_{kt}}{\sum_{k\neq i} POP_{kt}} - \frac{RGDP_{it}}{POP_{it}}\right| + \left|\frac{\sum_{k\neq j} RGDP_{kt}}{\sum_{k\neq i} POP_{kt}} - \frac{RGDP_{jt}}{POP_{jt}}\right|\right\}$$

Note that Baier and Bergstrand [2004] use capital-labor ratios. However, due to the availability of data, I follow EL and use differences in real GDP per capita.

3.3.4 Data sources and measurement issues

The analysis is based on a combination of a variety of data sets. The PTA dummy is obtained from a comprehensive data set assembled by Baier and Bergstrand [2009]. Based on information from the World Trade Organization among other sources, this data set covers 195 countries and provides information on which countries are engaged in any kind of preferential trade arrangement between 1960 and 2005. PTAs include, by increasing degree of integration, non reciprocal preferential trade agreements given by developed nations to developing countries, preferential trade agreements, free trade areas, customs unions, common markets and economic unions. I exclude non reciprocal PTAs from the analysis and group all the others under the terminology of PTA.

Data on bilateral trade flows is from the NBER-United Nations Trade Data constructed by Feenstra, Lipsey, Deng, Ma, and Mo [2005]. Combining data from Statistics Canada's World Trade Database and the United Nations Commodity Trade database (UN Comtrade), this database provides information on bilateral imports at 4-digit Standard International Trade Classification (SITC), revision 2 for the period 1962-2000. An interesting feature of this database is that they use primarily the trade flow as reported by the importing country and adopt mirror statistics when such data is not available, thereby increasing the coverage. In the calculation of the trade complementarity index, I aggregate the data to obtain flows at 2-digit SITC level (divisions), yielding 73 items.

The bilateral distance measure is downloaded from the CEPII website. [13] The dataset covers

13. http ://www.cepii.fr/anglaisgraph/bdd/distances.htm.

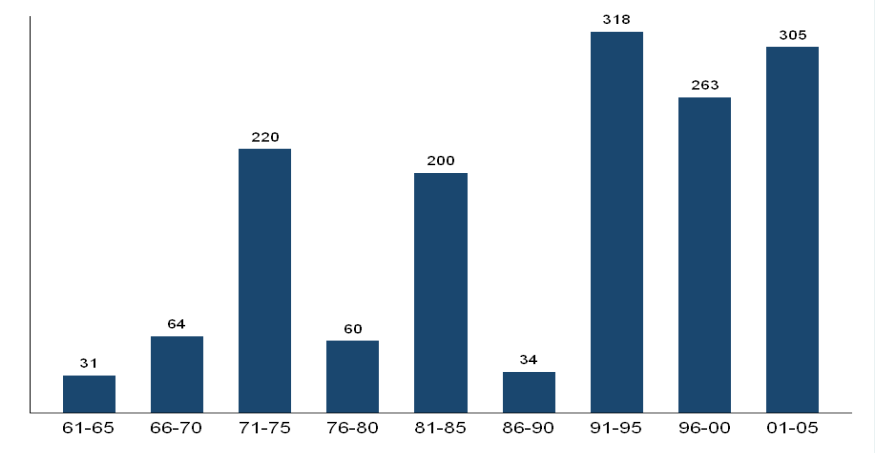
225 countries and presents, among other distance between the most populated cities or agglomerations in the countries calculated following the great circle formula. Data on real GDP and population are obtained from the World Bank's (2009) World Development Indicators. Real GDP corresponds to GDP measured in 2000 US dollars.

3.4 Results

3.4.1 RTA formation and summary statistics

I start with some summary statistics about PTA formation over the period of study. Figure 3.1 presents the number of country-pairs that have formed a new PTA during each of the 5-years periods from 1961 to 2005. Note that I do not differentiate between bilateral and multilateral PTAs : any enlargement is considered as the creation of a PTA between the new member and each of the existing member. This differs from EL who considered separately the formation of new PTAs from the enlargement of existing ones. [14]

Figure 3.1 – Number of country-pairs forming a new PTA between 1961 and 2005



Over the whole period of 1961-2005, about 1,499 country-pairs have formed a PTA. From the figure, it is possible to identify periods of active PTA formation and periods of relatively slow PTA

14. For instance, the accession of Greece to the European Economic Community (EEC) in 1981 is treated as the creation of a bilateral PTA between Greece and each of the countries that were already member.

formation. For instance, between 1971 and 1975, about 220 country-pairs entered a PTA. This reflects among others the formation of the Caribbean Community [15] and the first enlargement of the European Community with the accession of the United Kingdom, Ireland and Denmark. The second wave of regionalism occured between 1981 and 1985. A major event during this period is the accession of Greece to the EC and the establishment of the Gulf Cooperation Council as a common market between Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates.

Another interesting fact from the figure is that since 1991-1995, the number of new country-pairs forming a PTA remains high, well above 2000. For instance, 318 country-pairs formed a PTA between 1991 and 1995. One could attribute this proliferation to the enlargement of major PTAs such as the European Community because a single country joining one of these PTAs is treated as the creation of as many bilateral PTAs as there are countries. This period is marked by several free trade areas involving the European Community (former EEC) and countries such as Andorra, Bulgaria, Czech and Slovakia, the creation of the Southern Common Market (Mercosur) in Latin America and the creation of the Western Africa Economic and Monetary Union (WAEMU).

However, this was also a period of dynamic regionalism with countries moving towards bilateral trade agreements as well. An indicator that would not be prone to the effect of the enlargement of large preferential trade areas is the number of PTAs notified to the WTO. Such number is not affected by the size of multilateral PTAs since bilateral PTAs and multilateral PTAs are counted identically. A study by Crawford and Fiorentino [2005] reported that from 1995 to 2005, 196 new PTAs have been notified to the World Trade Organization, compared to 124 PTAs during the 4 decades of the GATT era. The figure clearly suggests that if there is interdependence, the effects must have been stronger over the last two decades.

3.4.2 Estimation results

Table 3.II presents the results of the panel data model estimation of the determinants of PTA formation. I report the results under three different specifications. All these specification differ in the weighting matrix used to capture interdependence.

15. The Caribbean Community was established in 1973 as a customs union between Barbados, Guyana, Jamaica, and Trinidad and Tobago. Seven countries will join the next year, raising the number of members to 11. These are : Antigua and Barbuda, Belize, Dominica, Grenada, Montserrat, Saint Kitts and Nevis, Saint Lucia and Saint Vincent and the Grenadines. Suriname will join later in 1995 and Haiti in 2002.

In Column (1) I report the results in a basic specification that does not take into account interdependence, that is, all the elements of W_{t-5} are set to zero. In column (2), I use the distance-based weighting matrix as in EL. It is therefore a replication of their results although I do not differential between PTA formation and PTA enlargement. [16] Column (3) presents results in the case where the weighting matrix is based on the measure of the potential of trade diversion.

Comparing across the specifications, the effects of the common variables are unchanged and in general, not qualitatively different from the other studies such as Baier and Bergstrand [2004] or EL. The results confirm the importance of natural trading partners in PTA formation. The coefficient on the natural logarithm of the bilateral distance in negative and highly significant, suggesting that PTAs are more likely to be formed among countries that are geographically close. I also find that PTAs are more likely to be formed between larger countries ($\hat{\beta}_{\text{RGDPsum}} > 0$) and also countries that are of similar size in terms of their GDP share ($\hat{\beta}_{\text{RGDPsim}} > 0$).

Turning to income differences, I find a positive effect of the difference in income per capita on the probability of PTA formation. However, the coefficient of the square term is negative and significant, suggesting that the relationship is in fact non linear. This is in favor of Krueger's (1999) logic of trade gains based on comparative advantage for countries with different levels of income per capita. EL found a negative coefficient on the difference in GDP per capita and a positive one on the squared-term. The results is however not robust since results from the cross-sectional probit show the reverse sign.

Considering variables measuring the situation of the country-pair compared to the rest of the world, I find that a pair of remote countries (but located on the same continent) are more likely to form a PTA ($\beta_{\text{REMOTE}} > 0$). This support the argument of Frankel, Stein, and Wei [1995] that the welfare from forming a PTA between such pair of countries is higher because there is less scope for trade diversion with the rest of the world. The reason is that such pair of countries is already trading less with the rest of the world because they are more likely to face higher transport costs with such partners.

16. Another key difference is that they treat multilateral PTAs as a single country.

Tableau 3.II – Panel Probit results for the probability of a new PTA, 1966 and 2005

Dependent variable : newPTAs			
	(1)	(2)	(3)
$W_{t-5}\text{PTA}_{t-5}$			
Trade diversion			1.762**
			-0.15
Distance-based		2.492**	
		-0.208	
NATURAL	-0.820**	-0.733**	-0.684**
	-0.036	-0.036	-0.036
RGDPsum	0.206**	0.217**	0.192**
	-0.014	-0.015	-0.014
RGDPsim	0.190**	0.197**	0.177**
	-0.018	-0.02	-0.018
DKL	0.236**	0.216**	0.193**
	-0.06	-0.064	-0.06
square DKL	-0.110**	-0.112**	-0.103**
	-0.017	-0.018	-0.017
REMOTE	0.037**	0.041**	0.037**
	-0.005	-0.005	-0.005
DRWOWKL	-0.031**	-0.030**	-0.030**
	-0.011	-0.012	-0.011
Constant	-0.229	-1.435**	-1.115**
	-0.335	-0.373	-0.341
Pseudo-R2	0.361	0.377	0.374
Observations	54 113	54 113	54 113
Nb of country-pairs	11 893	11 893	11 893

Notes : Standard errors are reported below the coefficients.
$*$ significant at 5% ; $**$ significant at 1%.

I now turn to the interdependence variables. Consistent with EL's finding, country-pairs that are geographically close to PTAs are more likely to form a PTA themselves (column (2)). The coefficient estimate is 2.42 and significant at 1 percent level, a value that is within the the range of their estimates. Results in column (3) point to a significant impact of the potential of trade diversion on the likelihood of two countries forming a PTA. I find a point estimate coefficient

of 1.76, supporting the view that countries that face a higher risk of trade diversion due to the presence of neighboring preferential trade agreements are more likely to enter a PTA themselves the following years. The coefficient is significant at 1 percent level. To measure the goodness-of-fit of the model, I report the pseudo R2. For the model with interdependence, the pseudo R2 is 0.37, suggesting that the model "explains" about 37 percent of variation in the formation of new PTAs. [17]

3.4.3 Robustness check

The measure of trade diversion shares a common feature with EL's distance-based measure : it uses the same criteria to select country-pairs considered as geographically close. Hence, it is possible that the results are driven by a common determinant : distance. To show that this is not the case, I consider alternative specifications including both measures.

Tableau 3.III – Panel estimation of PTA formation : marginal effects

Dependent variable : newPTA

	(1A)	(1B)	(2A)	(2B)	(3A)	(3B)
	Prob.	Marg.	Prob.	Marg.	Prob.	Marg.
$W_{t-5}\text{PTA}_{t-5}$						
Trade diversion	0.799**	0.003**		0.0004**	1.175**	0.005**
	-0.211	0.002		0.00009	-0.281	0.002
Distance-based	1.814**	0.007**		0.0005**	2.037**	0.009**
	-0.273	0.001		0.00011	-0.296	0.002
Interaction of both			4.042**		-1.688	
			-0.397		-0.866	
Pseudo-R2	0.378		0.370		0.378	
Observations	54 113		54 113		54 113	
Number of id	11 893		11 893		11 893	

Notes : Standard errors are reported below the coefficients.
$*$ significant at 5% ; $**$ significant at 1%.

As can be seen from columns (1A) and (3A), the coefficient on the trade-diversion based interdependence variable is positive, supporting the view that this measure captures more than geographical proximity with existing PTAs. The coefficient on the distance-based weighting matrix

17. The pseudo R2 is calculated as one minus the ratio of the log-likelihood value for the estimated model to that for the model with only an intercept.

is however higher, suggesting the predominance of distance in PTA formation. It is important to note that the two effects are not exclusive. For instance, one can think about the trade-diversion based measure as important in inducing countries to seek a PTA, and the distance-based measure as important in their choice of the PTA partner.

The importance of the two determinants is confirmed in columns (1B), (2B) and (3B) reporting the marginal effects of each of the measures. The marginal effects are calculated at the mean of the independent variables and correspond to the effect of these variables on the probability of a positive outcome. Although these variables are not measuring any economic quantity and the interpretation of their coefficient in isolation does not make much sense, their relative magnitude can be informative. These results show that the interdependence measure based on trade diversion is economically significant, even when distance is controlled for. The marginal effect is significant but roughly half of the effect of the distance-based measure.

3.5 Conclusion

In this paper, I extend Egger and Larch [2008] to explore the role of trade diversion in PTA formation. Using product-level trade data, I derive an index capturing to what extent products exported by excluded countries are likely to suffer from trade diversion in preferential trade areas. The index measures the similarity between products exported by the outsiders and products that PTA members import from each other. The closer the match, the higher the potential of trade diversion. I find a significant effect of the threat of trade diversion on the probability of PTA formation. The result is robust to controlling for distance-based measure of interdependence. The results support also the importance of the natural trading partner hypothesis in PTA formation, that is, countries that are closer geographically exhibit a higher probability of entering a PTA.

This paper focuses on a particular aspect of interdependence in PTA formation : trade diversion. However, there are several other aspects that worth exploring, one of them being the terms of trade effects [Kowalczyk and Riezman, 2009, Winters and Chang, 2000]. In addition, as suggested by Baldwin [1993], the deepening of an existing PTA can induce excluded countries to seek similar arrangements as well. All those aspects are left for future research.

CONCLUSION GÉNÉRALE

Cette thèse a traité de trois sujets en macroéconomie ouverte et commerce international. J'ai examiné tour à tour les conditions sous lesquelles il est optimal de former une union économique, le phénomène d'accumulation des déséquilibres extérieurs et la relation avec l'investissement, et la prolifération des accords commerciaux préférentiels.

Le premier chapitre a identifié - du point de vue du revenu et du niveau des avoirs extérieurs nets - les conditions sous lesquelles il est optimal pour les pays de former une union économique. Contrairement à la littérature, le modèle capture non pas seulement les bénéfices mais également les coûts de l'intégration économique. Les bénéfices proviennent d'un meilleur partage du risque entre pays membres et d'une gestion plus efficace des lignes de crédit, notamment dans les situations où un des pays est contraint et l'autre ne l'est pas. Mais une telle opportunité n'est pas sans conséquence pour le partenaire riche qui se retrouve plus fréquemment contraint au niveau des marchés internationaux des capitaux. Conformément aux faits empiriques établis, le modèle prédit que les unions économiques sont rares et tendent à regrouper des partenaires généralement riches et/ou relativement homogènes.

Certains aspects de l'analyse peuvent être approfondis et d'autres directions, explorées plus en détails. Par exemple, une des hypothèses retenues est que les chocs de productivité entre les pays sont indépendants. En réalité, avec l'intégration accrue des marchés et la mondialisation des échanges les économies sont devenues plus interdépendantes et les chocs tendent à être corrélés. D'autre part, l'analyse s'était limitée à la dimension "partage de risque" comme motivation de l'intégration économique. Il serait intéressant d'explorer les autres motivations comme la libre circulation des biens (Melitz [2003], Alvarez and Lucas [2007]), la libre circulation de la main d'œuvre (Klein and Ventura [2007]) et des investissements (Castro [2005], Burstein and Monge-Naranjo [2009], McGrattan and Prescott [2009]).

L'analyse des déséquilibres extérieurs menée dans le deuxième chapitre montre que la dispersion croissante des avoirs extérieurs nets résultant d'une réduction des barrières aux mouvements des capitaux ne se traduit pas nécessairement par une dispersion accrue des taux d'investissement. Ceci, parce qu'en dépit d'une meilleure intégration des marchés financiers, les incitations à investir

peuvent rester inchangées. Dans l'analyse, j'ai fait abstraction des différentes barrières et distorsions causées par les institutions et politiques économiques, et qui peuvent affecter l'accumulation du capital (regulations, corruption, droits de monopole,...) . Ces barrières peuvent cependant expliquer une grande partie de la disparité observée au niveau des taux d'investissements comme l'ont souligné Restuccia and Urrutia [2001], et les prédictions du modèle quant à la dispersion des taux d'investissement peuvent être améliorées en modélisant ces barrières.

Dans le dernier chapitre, j'ai analysé empiriquement un aspect de l'interdépendance dans la prolifération des accords commerciaux régionaux. J'ai montré que la perte potentielle des marchés à l'exportation peut inciter les pays exclus de ces accords à rechercher l'adhésion ou à créer de nouveaux accords. Comme dans la plupart des analyses dans la littérature, l'attention est portée ici sur l'effet des accords préférentiels sur les volumes de commerce. Mais les accords commerciaux préférentiels n'affectent pas que les volumes de commerce des pays exclus : ils affectent aussi leurs termes de l'échange (Mundell [1964]). Ces effets ont été mis en évidence par Winters and Chang [2000] dans le cas de l'accession de l'Espagne à l'Union Européenne (Communauté économique européenne à l'époque) et Gupta and Schiff [1997] dans le cas de l'impact du Pacte Andin sur l'Argentine. Une analyse complémentaire consisterait à examiner dans quelle mesure ces effets sur les termes de l'échange peuvent expliquer la prolifération des accords que nous observons.

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Annexe I

Annexes au chapitre 1

I.1 Data

I.1.1 Regional Agreements

The list of regional trade agreements that we use in the regression analysis of Section 1.2, by type, and their country composition, is as follows:

- **Economic Unions.** *Economic and Monetary Community of Central Africa* (Cameroon, Central African Republic, Chad, Congo D.R., and Equatorial Guinea), *Euro zone* (Austria, Belgium, Luxembourg, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain), and *West African Economic and Monetary Union* (Benin, Burkina Faso, Guinea-Bissau, Cote d'Ivoire, Mali, Niger, Senegal, and Togo).
- **Common Markets.** In addition to all Economic unions: *East African Community* (Kenya, Tanzania, and Uganda), and *European Economic Area* (comprising the European Free Trade Area of Iceland, Liechtenstein, and Norway, plus all the countries in the EU25).
- **Customs Unions.** In addition to all Common Markets: *Andean Community* (Bolivia, Colombia, Ecuador, Peru, and Venezuela), *Caribbean Community* (Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Montserrat, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, and Trinidad and Tobago), *Eurasian Economic Community* (Belarus, Kazakhstan Kyrgyzstan, Russia, and Tajikistan), *EU25-Turkey* (all the countries in the EU25 plus Turkey), *Gulf Cooperation Council* (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates), *Southern Common Market* (Argentina, Brazil, Paraguay, and Uruguay), and *South African Customs Union* (Botswana, Lesotho, Namibia, South Africa, and Swaziland).

I.1.2 Countries

The full sample of 136 countries that we use in the regression analysis of Section 1.2 includes: Algeria, Angola, Antigua and Barbuda, Argentina, Australia, Austria, Bahrain, Bangladesh, Bel-

gium, Belize, Benin, Bhutan, Bolivia, Brazil, Bulgaria, Burkina Faso, Burundi, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Comoros, Congo D.R., Congo Rep., Costa Rica, Côte d'Ivoire, Cyprus, Czech Republic, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Kiribati, Korea, Kuwait, Lao PDR, Liberia, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Mozambique, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Rwanda, Samoa, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, Solomon Islands, South Africa, Spain, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, Sweden, Switzerland, Syrian Arab Republic, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, United Arab Emirates, United Kingdom, United States, Uruguay, Venezuela, Vietnam, Yemen, Zambia, and Zimbabwe.

I.2 Decentralization

We decentralize the planner's allocation as a competitive equilibrium with tax subsidies on saving. Our decentralization scheme is an adaptation of Wright [2006]. [1] Within the union, countries trade a complete set of Arrow securities. In the world market, they trade freely on a riskless one-period bond. A central government authority in the union implements a tax and transfer scheme, designed to support the constrained-efficient allocation, and thus prevent default in the appropriate states.

For each country $i = 1,2$ in the union, let $a_i(\bar{y}';b_i,\bar{b},\bar{y})$ denote the net stock of the Arrow security that pays in state $\bar{y}'$ tomorrow, conditional on individual wealth b_i and the aggregate state $(\bar{b},\bar{y})$, with price $q(\bar{y}';\bar{b},\bar{y})$. Let $b_i'(b_i,\bar{b},\bar{y})$ denote the net stock of foreign bonds that earn interest r tomorrow.

1. Wright [2006] uses taxes on borrowing instead of saving subsidies, although the two are equivalent. Wright [2006] also studies an alternative decentralization based upon country-specific borrowing limits, along the lines of Alvarez and Jermann [2001].

Let also $\tau(\bar{b},\bar{y})$ denote the subsidy rate on net asset purchases, and $T_i(b_i,\bar{b},\bar{y})$ the lump-sum income tax faced by country i.

In a competitive equilibrium with capital controls, country i solves the following problem for every current state

$$V_i(b_i,\bar{b},\bar{y}) = \max_{c_i,b_i',\{a_i(\bar{y}')\}} \left\{ u(c_i) + \beta \sum_{\bar{y}'} \pi\left(\bar{y}'|\bar{y}\right) V_i\left(b_i',\bar{b},\bar{y}'\right) \right\}$$

subject to

$$c_i + \left(1-\tau\left(\bar{b},\bar{y}\right)\right)\left(b_i' + \sum_{\bar{y}'} q\left(\bar{y}';\bar{b},\bar{y}\right) a_i\left(\bar{y}'\right)\right) \quad = \quad b_i + T_i\left(b_i,\bar{b},\bar{y}\right) \tag{I.2.1}$$

and to a perceived law of motion for aggregate foreign asset holding $\bar{b}$.

The government is assumed to run a balanced budget for each country separately, that is

$$\tau\left(\bar{b},\bar{y}\right)\left(b_i'\left(b_i,\bar{b},\bar{y}\right) + \sum_{\bar{y}'} q\left(\bar{y}';\bar{b},\bar{y}\right) a_i\left(\bar{y}';b_i,\bar{b},\bar{y}\right)\right) = T_i\left(b_i,\bar{b},\bar{y}\right) \tag{I.2.2}$$

for every current state and for each i.

A competitive equilibrium with tax subsidies is defined in the standard way, as (i) optimal decision rules that solve each country's problem given prices, government policy, and a perceived law of motion for aggregate wealth; (ii) a government policy that satisfies the balanced budget constraints given prices and individual decisions; (iii) Arrow security prices that clear asset markets; and (iv) consistency between the perceived law of motion for aggregate asset holding and the individual decision rules.

Our goal here is to show that there exists a government tax and transfer policy that supports the constrained-efficient allocation as a competitive equilibrium. We focus on the key steps of the argument.

Consider the first-order conditions to the country's problem

$$1-\tau\left(\bar{b},\bar{y}\right) = (1+r)\sum_{y'}\pi\left(\bar{y}'|\bar{y}\right)\frac{\beta u'\left(c_i(b_i',\bar{b}',\bar{y}')\right)}{u'\left(c_i(b_i,\bar{b},\bar{y})\right)} \tag{I.2.3}$$

$$\left(1-\tau\left(\bar{b},\bar{y}\right)\right)q\left(\bar{y}';\bar{b},\bar{y}\right) = \pi\left(\bar{y}'|\bar{y}\right)\frac{\beta u'\left(c_i\left(b_i',\bar{b}',\bar{y}'\right)\right)}{u'\left(c_i\left(b_i,\bar{b},\bar{y}\right)\right)}. \tag{I.2.4}$$

Given isoelastic preferences, the last equation implies

$$\frac{c_i\left(b_i',\bar{b}',\bar{y}'\right)}{c_i\left(b_i,\bar{b},\bar{y}\right)} = \frac{c\left(\bar{b}',\bar{y}'\right)}{c\left(\bar{b},\bar{y}\right)} \text{ for } i=1,2. \tag{I.2.5}$$

The two Euler equations imply

$$1=(1+r)\sum_{\bar{y}'}q\left(\bar{y}';\bar{b},\bar{y}\right). \tag{I.2.6}$$

Note also that, at the optimum, we may use (I.2.2) to eliminate subsidies and transfers from (I.2.1):

$$c_i\left(b_i,\bar{b},\bar{y}\right)+b_i'\left(b_i,\bar{b},\bar{y}\right)+\sum_{\bar{y}'}q\left(\bar{y}';\bar{b},\bar{y}\right)a_i\left(\bar{y}';b_i,\bar{b},\bar{y}\right)=b_i. \tag{I.2.7}$$

Consider now the constrained-efficient allocation, the solution to problem (P1′). This allocation, which we denote with a star superscript, satisfies the planner's Euler equation

$$u'\left(c^*\left(\bar{b},\bar{y}\right)\right)-\phi^*\left(\bar{b},\bar{y}\right)=\beta(1+r)\sum_{\bar{y}'}\pi(\bar{y}'|\bar{y})u'\left(c^*\left(\bar{b}',\bar{y}'\right)\right). \tag{I.2.8}$$

Using (I.2.5) in (I.2.3), and requiring that the resulting allocation be consistent with (I.2.8), it is easy to compute the state-contingent subsidy rates that implement the constrained-optimal allocation as

$$\tau\left(\bar{b},\bar{y}\right)=\frac{\phi^*\left(\bar{b},\bar{y}\right)}{u'\left(c^*\left(\bar{b},\bar{y}\right)\right)}. \tag{I.2.9}$$

Note that if the borrowing constraint to problem (P1′) does not bind in state $\left(\bar{b},\bar{y}\right)$, then $\phi^*\left(\bar{b},\bar{y}\right)=0$ and so $\tau\left(\bar{b},\bar{y}\right)=0$. In this case, from (I.2.4) and (I.2.6), the domestic interest rate equals the world interest rate. If the constraint is instead binding, then the (post-subsidy) domestic interest rate is higher than the world interest rate. This ensures that countries save in a constrained-

optimal way, and that equilibrium borrowing is self-enforcing.

It is relatively straightforward to show formally that, given a constrained-efficient allocation that solves (P1′) and (P2) for the appropriate set of welfare weights, one can obtain individual asset holdings from (I.2.7) together with the market clearing condition for Arrow securities, Arrow security prices from (I.2.4), and a government policy from (I.2.9) and (I.2.2) that support that allocation as a competitive equilibrium with tax subsidies.

To find the appropriate set of welfare weights, we use the method proposed by Negishi [1960]. This method exploits the equivalence between the market and the constrained-efficient allocations.

We obtain the time-0 present value budget constraint of country i by iterating forward on the flow budget constraint (I.2.7). We express it as

$$C_i\left(b_{i0},\bar{b}_0,\bar{y}_0\right)=Y_i\left(\bar{b}_0,\bar{y}_0\right)+(1+r)\,b_{i0},$$

where $C_i\left(b_{i0},\bar{b}_0,\bar{y}_0\right)$ and $Y_i\left(\bar{b}_0,\bar{y}_0\right)$ are the time-0 present-values of consumption and the endowment, respectively. At time 0, the time of forming the union, $\bar{y}_0$ is the union's endowment pair, b_{i0} is country i's net stock of foreign bonds, and $\bar{b}_0=\sum_i b_{i0}$ is the union's aggregate asset.

It follows from (1.4.4) that we may express the present value of individual consumption as fraction of the present value of aggregate (constrained-efficient) consumption, that is $C_i\left(b_i,\bar{b},\bar{y}\right)=\alpha_i C^*\left(\bar{b},\bar{y}\right)$. Replacing above allows us to recover the individual consumption share parameters as

$$\alpha_i=\frac{(1+r)\,b_{i0}+Y_i\left(\bar{b}_0,\bar{y}_0\right)}{C^*\left(\bar{b},\bar{y}\right)}. \tag{I.2.10}$$

Given equilibrium Arrow security prices $q\left(\bar{y}';\bar{b},\bar{y}\right)$, and optimal decision rules $c^*\left(\bar{b},\bar{y}\right)$ and $b^{*\prime}\left(\bar{b},\bar{y}\right)$, the C^* and Y functions solve the following functional equations

$$Y_i\left(\bar{b},\bar{y}\right) = y_i+\sum_{\bar{y}'}q\left(\bar{y}';\bar{b},\bar{y}\right)Y_i\left(\bar{b}',\bar{y}'\right) \tag{I.2.11}$$

$$C^*\left(\bar{b},\bar{y}\right) = c^*\left(\bar{b},\bar{y}\right)+\sum_{\bar{y}'}q\left(\bar{y}';\bar{b},\bar{y}\right)C^*\left(\bar{b}',\bar{y}'\right) \tag{I.2.12}$$

with

$$\bar{b}'=b^{*\prime}\left(\bar{b},\bar{y}\right)$$

Notice that although it is straightforward to obtain the welfare weights from the consumption share parameters, we only need to know the α_i's in order to uncover the individual allocations.

I.3 Numerical algorithms

I.3.1 World economy equilibrium

Our algorithm can be described in the following steps:

1. Solve for the autarky value function $V_{aut}(y)$ from equation (1.3.6).
2. Given a current guess for the equilibrium interest rate r, solve problem (P0) by iterating on the following steps:
   (a) Consider the n^{th} iteration, with a current conjecture for the debt limit b_n^W. For the initial conjecture, we use the natural borrowing constraint.
   (b) Given b_n^W, solve problem (P0) by policy function iteration. We discretize the state-space and use cubic-spline interpolation to compute decisions outside the grid.
      i. First find the decision rules that solve the system of first-order conditions to problem (P0), ignoring the debt limit. Consider the j^{th} iteration, with a current conjecture for the consumption decision rule $c_n^j(b,y)$. Compute a candidate update $c_n^{j+1}(b,y)$ by solving

$$u'\left(c_n^{j+1}(b,y)\right) = \beta(1+r)\sum_{y'}\pi(y'|y)u'\left(c_n^j(b',y')\right)$$

      with

$$b' = y + (1+r)b - c_n^{j+1}(b,y).$$

      As part of the solution, we obtain $b_n'^{j+1}(b,y)$.
      ii. Check whether the borrowing constraint is violated. If $b_n'^{j+1}(b,y) < b_n^W$, then up-

date the solution as follows:

$$\begin{aligned} b_n'^{j+1}(b,y) &= b_n^W \\ c_n^{j+1}(b,y) &= b - b_n'^{j+1}(b,y) \\ \phi_n^{j+1}(b,y) &= u'\left(c_n^{j+1}(b,y)\right) - \beta(1+r)\sum_{y'}\pi(y'|y)u'\left(c_n^{j+1}(b',y')\right), \end{aligned}$$

If instead $b_n'^{j+1}(b,y) \geq b_n^W$, then update using the unconstrained solution, setting also $\phi_n^{j+1}(b,y) = 0$.

iii. Iterate on the previous two steps until the decision rules converge. At the end, compute the value function $V_n(b,y)$.

(c) Given $V_n(b,y)$, update the debt limit as follows:

$$b_{n+1}^W = \max_{y'}\left\{b_{y'} : V_n(b_{y'},y') = V_{aut}(y')\right\}.$$

(d) Iterate on steps 2b and 2c until the borrowing limits converge.

3. Check the market clearing condition by approximating the aggregate bond holding in the world economy with the total bond holding of a particular country over a very long simulation period. We discretize the state-space using a finer grid, and linearly interpolate the decision rules.

4. Iterate on steps 2 and 3 until we find an interest rate that approximately clears the bond market.

I.3.2 Union problem under centralized default

Our algorithm to solve for the union's allocation given an equilibrium world interest rate r can be described as follows:

1. Solve problem (P1′) using the method described in step 2 of the algorithm of Section I.3.1. As part of the solution we obtain the union decision rule $c^*(\bar{b},\bar{y})$, the multiplier function $\phi^*(\bar{b},\bar{y})$, and the value function $V^U(\bar{b},\bar{y})$.

2. Decentralize the union's constrained-efficient allocation as a competitive equilibrium with capital controls.
   (a) Compute tax-subsidies from (I.2.9).
   (b) Compute pre-subsidy Arrow-security prices from (I.2.4).
   (c) Compute the present-value functions from (I.2.11) and (I.2.12). In practice, we guess some arbitrary functions on a grid and then iterate on the two recursive equations until convergence. We linearly interpolate these functions when future wealth levels fall outside the grid.
   (d) Compute consumption shares from (I.2.10).
   (e) Compute the value function for each country from (1.4.6).

Annexe II

Annexe au chapitre 2

II.1 Data appendix

II.1.1 Net foreign asset positions

The list of countries includes: Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Belarus, Belgium, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cote d'Ivoire, Cambodia, Cameroon, Canada, Cape Verde, Central African Rep., Chad, Chile, China,P.R.: Mainland, China,P.R.:Macao, Colombia, Comoros, Congo, Dem. Rep. of, Congo, Republic of, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Ethiopia, Fiji, Finland, France, Gabon, Gambia, The, Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Islamic Republic of, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kiribati, Korea, Kuwait, Kyrgyz Republic, Lao People's Dem.Rep, Latvia, Lebanon, Lesotho, Liberia, Libya, Lithuania, Luxembourg, Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russia, Rwanda, Sao Tome & Principe, Samoa, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Singapore, Slovak Republic, Slovenia, Solomon Islands, South Africa, Spain, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent & Grenadines, Sudan, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Tajikistan, Tanzania, Thailand, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Vanuatu, Venezuela, Rep. Bol., Vietnam, Republic of Yemen, Zambia and Zimbabwe.

II.2 The computation algorithm

We solve the recursive model defined by equations 2.3.8 and 2.3.9 using three layers of iterations with stopping criteria respectively to $\varepsilon_c = 10^{-6}$, $\varepsilon_b = 10^{-5}$ and $\varepsilon_r = 10^{-2}$. The iterations are as follows:

- At the lower level, we take the interest rate and the debt limit as given and iterate on Euler equations to find decision rules for consumption $c_{n+1}(.)$, capital $k_{n+1}(.)$ and bond holding $b_{n+1}(.)$. The algorithm exits this level if two successive iterations give decision rules that are close, that is $\|c_{n+1}(.) - c_n(.)\| \leq \varepsilon_c$.
- At the second level, we take the world interest rate as given and iterate on debt limit $B_n(.)$ until $\|B_{n+1}(.) - B_n(.)\| \leq \varepsilon_b$;
- At the first level, we iterate on r until the market for bonds clears. That is: $\|E_r b'\| \leq \varepsilon_r$.

We now present in more details the steps involved:

Step 1: Solve the model of financial autarky and calculate the value function $V^{aut}(.)$.

Step 2: Conjecture an upper and a lower bound for the equilibrium interest rate and pick $r \in [r_l, r_h]$.

Step 3: Conjecture an initial debt limit $B_0(.) = -D$ where D is high enough so that the constraint never binds in equilibrium.

Step 4: Let's assume that we arrive after the n^{th} iteration with an endogenously determined debt limit $B_n(.)$. [1]

Step 5: Solve the model for equilibrium functions $V^n(.)$, $c^n(.)$, $k^n(.)$ and $b^n(.)$ by iteration on Euler equations. It is as follow:

1. Guess initial decision rules $c_0(.)$, $k_0(.)$, $b_0(.)$.
2. Again, let's assume that after j iterations we arrive at decision rules $c_j(.)$, $k_j(.)$ and $b_j(.)$. For each state (b,k,s):
   - Assume that the borrowing constraint is not binding and use a nonlinear root finder

1. Note that the borrowing limit $B_n(.)$ determined after each iteration is a concave function of the state variable k. Therefore, the problem is well defined at each iteration.

to solve the following set of equations for (c,k',b'):

$$
\begin{aligned}
[\theta+\psi_2(k,k')]u'(c) &= \beta E_s\left[\left(r_{k'}-\psi_1(k',k'_j)\right)u'(c'_j)-\mu'_j\frac{\partial B'_n}{\partial k'}\right] \quad \text{(II.2.1)}\\
u'(c) &= \beta(1+r)E_s\left[u'(c'_j)-\mu'_j\frac{\partial B'_n}{\partial b'}\right] \quad \text{(II.2.2)}\\
c+\theta k'+b'+\psi(k,k') &= \omega
\end{aligned}
$$

where $r_{k'}\equiv\alpha z' k'^{\alpha-1}+(1-\delta)k'$.

– Check wether $b'<B^n(b,k,s)$. If so, set $b'=B^n(b,k,s)$ and use equation II.2.1to solve for k'. Else, decision rules c_{j+1},k_{j+1},b_{j+1} are found.

3. Iterate on step 2 until $||c_j(.)-c_{j+1}(.)||\leq\varepsilon_c$. In this case, decision rules associated with the borrowing limit $B_n(.)$ are found. We set $c^n(.)$, $k^n(.)$ and $b^n(.)$ to the final solution and compute $V^n(.)$ simply by iteration as follows:

$$V^n(b,k,s)=u(c^n)+\beta E_s V^n(b',k',s')$$

where $k'=k^n(b,k,s)$ and $b'=b^n(b,k,s)$.

Step 6: Once $V^n(.)$ is computed, update the debt limit as follow. For each state (b,k,s) the new debt limit $B^{n+1}(\omega,k,s)$ is the number $\hat{b}'$ such that:

$$\hat{b}'=\max_{s':\pi(s'|s)>0}\left\{b_{s'}:V^n\left(\omega',k',s'\right)=V^{aut}\left(k',s'\right)\right\}$$

with $k'=k^n(b,k,s)$ and $b'=b^n(b,k,s)$.

Step 7: Check wether $||B^{n+1}(.)-B^n(.)||\leq\varepsilon_b$. If it is the case, the endogenous debt limit is found and the second loop of the algorithm is exited. Else, one has to return to step 2.

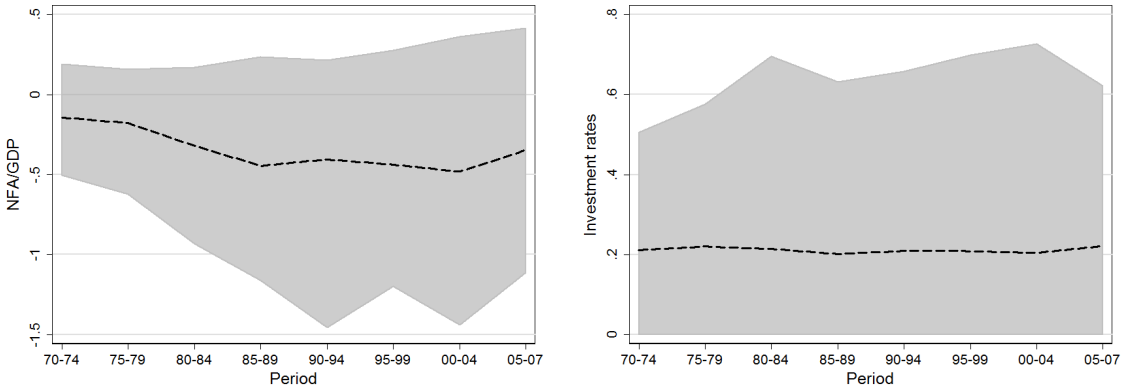
Step 8: Check whether the market for bond clears. We first generate a series of length $T=100,000$ for the productivity shock. Then, from an arbitrary initial condition, we iterate forward on decision rules to compute a series of length T for asset. We drop the first 1000 observations in order to abstract from the effect of the arbitrary initial condition and approximate the excess demand on asset market $E_r b'$ by taking the arithmetic mean of the remaining

sequence of bond decision.

Step 9: We check wether $|E_r b'| \leq \varepsilon_r$. If it is so, equilibrium interest rate is found and the algorithm stops. Else, if $E_r b' < 0$ we set $r_{min} = r$. Otherwise, $r_{max} = r$. We pick a new interest rate in $[r_{min}, r_{max}]$ and returns to step 4. We typically set $r = (r_{min} + r_{max})/2$.

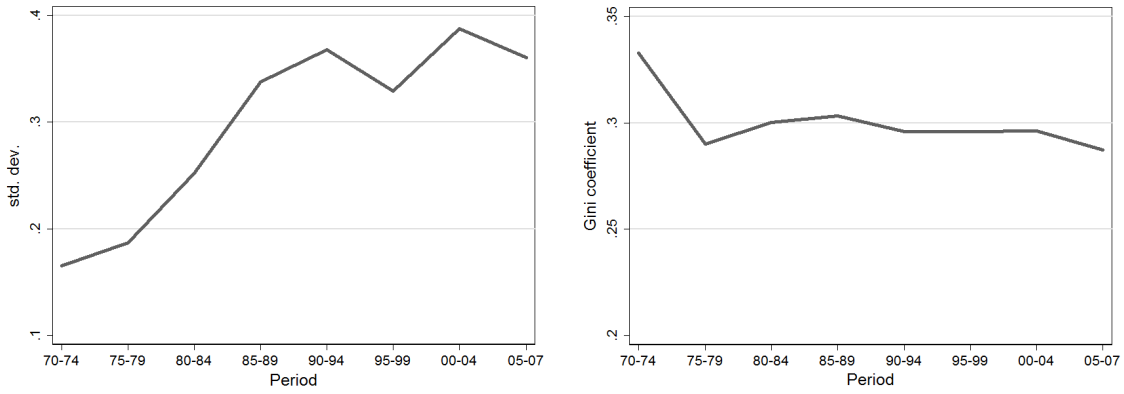
The model is solved using Lahey-Fujitsu Fortran 95. Nonlinear equations are solved using the IMSL routines DNEQNF and DZBREN. The grid for capital and asset positions contain 50 points each, spaced in such a way that there are more points near low level of capital and also the borrowing limit area. We evaluate decision rules for point outside the grid for capital and asset using quadratic interpolation (DQD2VAL).

II.3 Figures



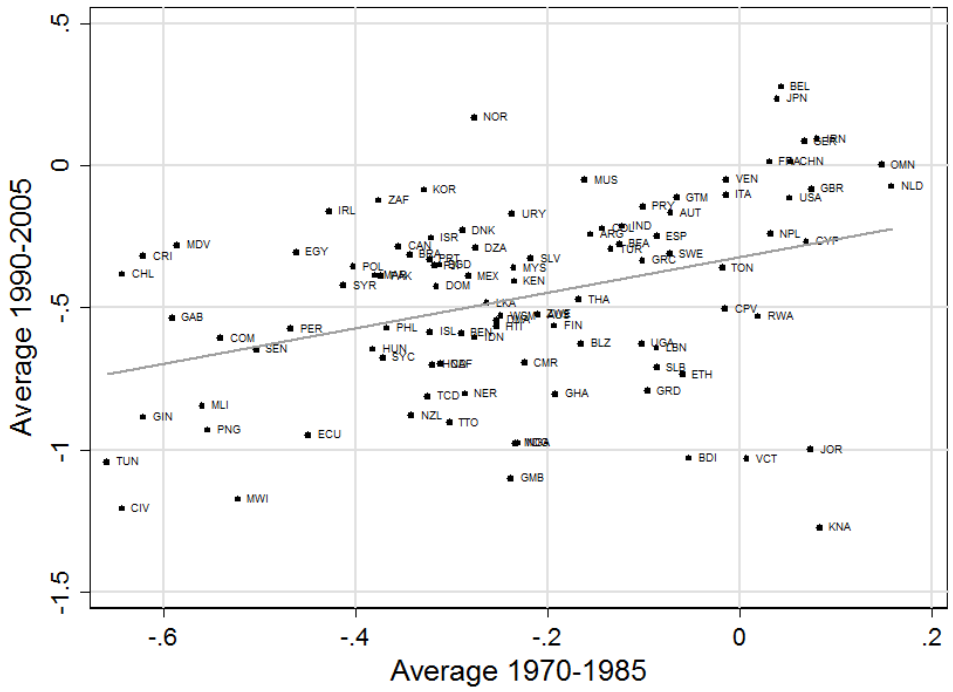
(a) NFA/GDP (b) Investment rate

Figure II.1: Evolution of the 80 percent range of NFA positions and investment rates, 1970-2007

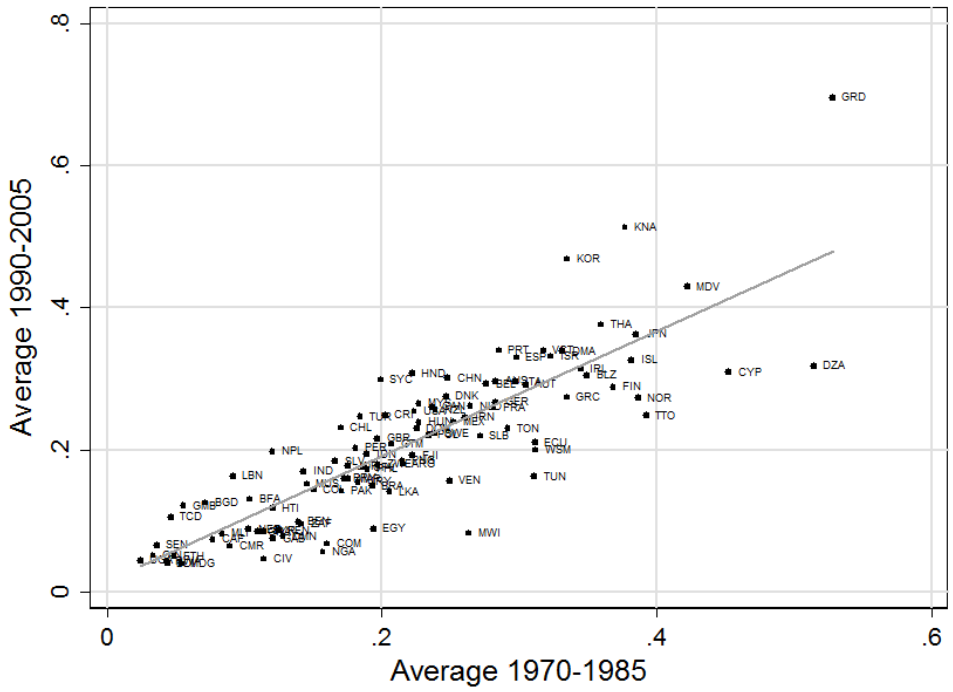


(a) NFA/GDP (b) Investment rate

Figure II.2: Evolution of the standard deviation, 1970-2007



(a) NFA positions (Coeff. correlation = 0.37)



(b) Investment rates (Coeff. correlation = 0.86)

Figure II.3: Persistence of NFA positions and investment rates